POWER PLANT ENGINEERING

GENERATION, TRANSMISSION AND UTILIZATION OF STEAM, ELECTRIC, DIESEL AND HYDRAULIC POWER

Contents

The Smoke Goes Up the Chimney Just the Same 422
With the Editors 423
Is College Education Advantageous? Going the Limit.
Quindaro's 30,000-kw. Addition. By R. L. Baldwin and A. C. Kirkwood 424
Combustion Control Specifications. By Richard H. Morris 430
Modernization of Paper Mill Power Plants. By K. R. Warrington 434
Reconnecting D.C. Armatures for Different Conditions. By E. F. Howes 438
High Pressure Extension of Detroit Edison's Delray Plant. By Max W. Benjamin 442
The Practical Engineer 459
Air Heater and Economizer Selector. By Adolf Johnson 475
Brewery Plant Modernization. By William Schuler 477
Synchronous Condenser Runs at High Speed 478
Electric Utility Executives Go to World's Fair 479
Smoke Prevention Association Meets in Milwaukee 483
New Equipment 484
Copper Oxide Rectifier. Hi-Lag Fuses. Return Idler. New Fluorescent Lamp Units.
A-C Motor Starter and Breaker. Air Trap. Steel Bins. Absorbent Type Filter. Sander.
Hydraulic Automatic Control. New Stroboscopes. Variable Speed Transmission. Enamel. Temperature Indicator. Infra-Red Ray Lamps for Drying.
Flow Meter Air Filter for Small Engines. Electric Hoist. Circuit Breaker. Spark-Arresters for Diesels.
Tension Measuring Wrenches. 2000 lb. Lubricator. Differential Controllers. Fire Observer. Conductivity Bridge.
Electric Hoist. Self-Regulating Battery Charger. Bearing Pillow Blocks. Adjustable Speed Drive. Electric Blower.
News from the Field 490
For the Engineer's Library 491
New Engineering Books 493
Power Plant Construction News 496

Contents of back issues of Power Plant Engineering will be found in Industrial Arts Index on file in Public Libraries.

JULY
1939

Vol. XLIII., No. 7

Published on the first of each month, copyright 1938 by the
Technical Publishing Co., 53 W. Jackson Blvd., Chicago.
New York Office, 171 Madison Ave.

EDITORIAL STAFF: ARTHUR L. RICE, Editorial Director R. E. TURNER, Editor.
A. W. KRAMER, Electrical Editor RICHARD H. MORRIS, Engineering Editor.

Subscription price. U. S. A. $2.00 a year; other countries, $3.50 a year. Single copy current issue, 25c; other countries, 35c. January issue, U. S. A., 50c; other countries, 60c. Back issues, single copy, U. S. A., 40c; other countries, 50c. January issue, U. S. A., 75c; other countries, 85c.

Member, Associated Business Papers, Audit Bureau of Circulations.

The Forced and Induced Draft Fans at Quindaro Station of the Kansas City Municipal System.

The Smoke Goes Up The Chimney Just The Same

IN A RECENT court proceedings public testimony is said to have been presented to the effect that, stacks are a thing of the past in power station practice. We have not endeavored to check the accuracy of this report, but it is quite possible that it is correct, since similar opinions have come to our attention in recent years. The idea has its origin, of course, in the fact that in certain instances power plants have been built with very short stacks, in fact in one case that we know of, because of the parapets around the top of the boiler house, the stack is not visible at all.

Insofar as draft is concerned, it is true, stacks can be dispensed with, since modern forced and induced draft fans adequately take care of any draft requirements, but to infer from this that the stack can be dispensed with, generally, implies an utter lack of knowledge of conditions. For regardless of how effective the draft producing apparatus may be, to employ a homely expression, "the smoke goes up the chimney just the same" and it is to minimize this smoke nuisance that stacks are still very necessary. High stacks discharge the flue gases and whatever dust may be in them high enough in the atmosphere so that it is spread over a wide area and thus reduce the smoke nuisance. For this reason stacks are still a very necessary, if sometimes unsightly adjuncts, to power plants, and any idea that they can be dispensed with in practice in the present state of the art is decidedly erroneous.

WITH THE EDITORS

Is College Education Advantageous?

MANY of those who have secured a college education are prone, in their reflections, to belittle the advantages this training has given them over those who did not spend the extra four years in furthering their cultural and professional training in a formal way at some college. The handicap encountered by the young college graduate without practical experience is tremendous. In any of the engineering branches about the only sure course open to him is to start at the bottom of the ladder as an apprentice in the power plant, factory or office in positions long passed by men of his own age who chose the practical, or, as many say, the hard way to advance in a profession. Under present industrial conditions seniority of employment is the strongest argument for advancement in the ranks of industry.

Notwithstanding these difficulties, the economic status of college alumni in the United States, as reported recently by the Office of Education, would indicate definite advantages in favor of college training. Some 46,000 college alumni graduated from 31 institutions of higher learning from 1928 to 1935 furnished information for this study. For instance, a typical graduate will enter an occupation at the age of 22 years paying about $1321 (median) for his first year. This will be nearly doubled ($2416, median) after eight years of practical experience, with 11 per cent in the higher brackets earning from $4000 to $5000 or more, while in the lower brackets 11 per cent received less than $1500. During this period, 98 per cent of the men alumni have never been on relief and 96 per cent were either permanently or temporarily employed. After graduation, 10 per cent of the men receiving degrees start in a business or profession of their own and after eight years 31 per cent are independent of employers. This does not refer to engineers alone but includes all classes of graduates.

It is also interesting to note the self reliance of modern college students, 68 per cent of whom, among the men, earned from one-fourth to all of their college expenses, and fully one-half of the graduates from 1928 to 1935 continued their formal education with graduate studies.

Without question, a large portion of the American youth is education conscious and will bend every effort available to develop their mental equipment for service in the social welfare of the country as well as personal gain to themselves. These young people enter college believing that such an education will be to their advantage. The engineering profession is definitely a product of colleges and most certainly without men with a working knowledge of the sciences, modern industry could not continue. So it is that the college has become a necessity to society at large if not to the individual.

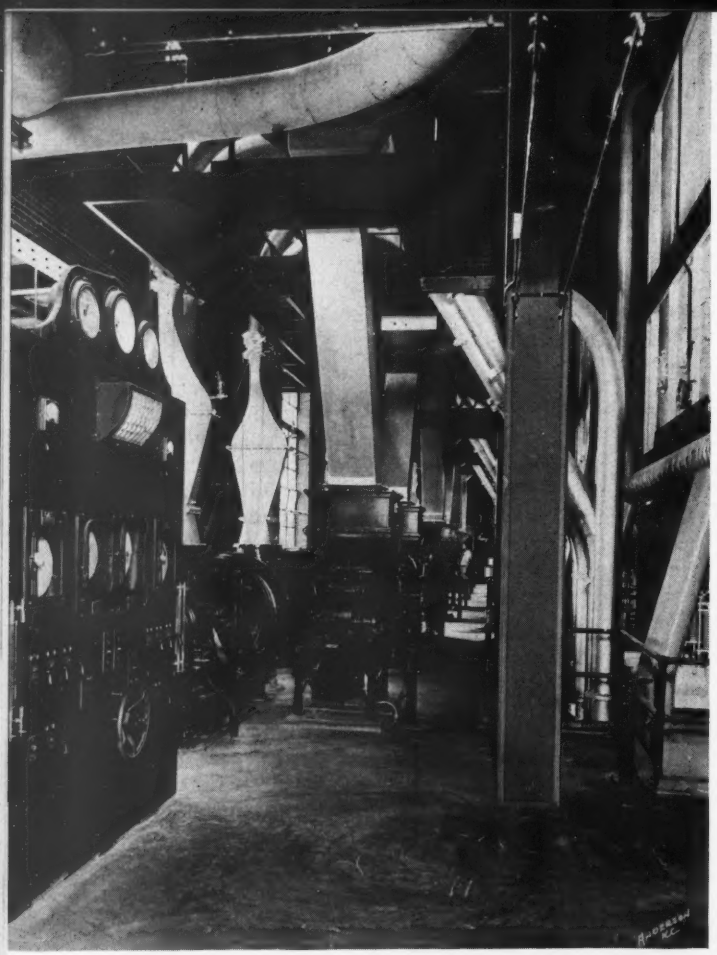
Going the Limit

SCIENCE HAS taught us that many practices in power plant operation could be improved in efficiency if physical conditions were changed to a point where a limit is reached. In the transmission of electricity, for example, the employment of an infinitely high voltage wound result in an infinitely low current and correspondingly low line losses. Limiting factors, however, present themselves in the form of space to prevent spark-over, insulating material and control equipment, all of which enter into the design of electrical machinery to such an extent that present commercial upper limits of voltage for power purposes are but a few hundred thousand and these applications are few.

If turbine speeds could be increased the space generating units occupy could be reduced. Higher furnace temperatures would, theoretically, increase heat absorption of the steam boiler. Theoretically perfect combustion,—no combustible in the refuse or waste gases and no free oxygen in flue gases—is almost attainable in modern plants. Perfect heat exchange may be attained by mixture, but where this is not possible, the material of which the tubes are made and the minimum of thickness are limiting factors. Steam pressure transmission losses are reduced by increasing the diameter of piping and reducing its length and fittings to a minimum. The theoretical limit of temperature and pressure of steam for power generation has been established by calculation and research, the attainment of these limits in commercial application, however, has been prevented largely because materials have not been economically available with which the engineer can generate and control this fluid under the theoretically most efficient conditions.

As an example of going to the practical, safe and economical limits in the construction and operation of power plants with present available materials, the Delray extension of the Detroit Edison Company is today one of the most outstanding examples. The extreme care with which the selection of materials and their use in design is made evident in the articles being printed serially in POWER PLANT ENGINEERING, and particularly is this true of the installment in this issue which deals exclusively with piping—materials, fittings, designs, installation, inspection.

Many years ago such scientists as Carnot, Rankine and Ohm indicated the way to highest efficiencies. Since their time engineers have been going to the limits set by materials economically available, safe working conditions restricted to a great extent by the knowledge of the men in charge of operation, and the finances procurable in developing the ideas into commercial undertakings. All of these conditions must be satisfied when an attempt is made to go the limit in the practical application of science to industry.



QUINDARO'S

BY

R. L. BALDWIN and A. C. KIRKWOOD

Burns & McDonnell Engineering Co.
Kansas City, Missouri

Fig. 1. (Above) A view on the operating floor in the boiler room

Fig. 2. (Right) Substantial in construction and of pleasing architectural design

Fig. 3. (On opposite page) The main electrical control room, typifies the smooth simplicity of design that characterizes the entire station

THE JUNE 15th 1932 ISSUE of POWER PLANT ENGINEERING described what was then the new, or No. 2, 10,000 kw. plant of the Quindaro Generating Station. In addition to the description of the plant, the article described the plan formulated to gradually replace the old, inefficient, low pressure plant with a modern plant of an ultimate capacity of 100,000 kw.

This new plant was proposed to have 1—10,000 and 3—30,000-kw. units with 6—150,000 lb. per hr. steam generators. The additional units were to be added as load growth and obsolescence of the old units indicated the need for further capacity. A steady growth in demand has made it necessary to install the first 30,000 kw. unit and the third steam generator in this plant. Contracts were awarded in the period July 1936 to July 1937 and the unit was placed in continuous operation during the summer of 1938. Completion of this addition to the plant and almost a year's operation makes it timely to describe this improvement and its adherence to the plant formulated some ten years ago.

The No. 1 plant's five generating units, totaling 29,000 kw. generate at 2300 v., which is stepped up to 13.2 kv. for transmission to the several substations. Steam pressure is 175 lb., temperature 480 deg. F. Several of the old boilers are kept in service at low ratings to maintain hot headers and readiness to assume load in emergencies. The main steam supply for this plant comes, however, from the new plant through pressure reducing valves and desuperheaters. Until the recent additions, all electric control was from the old plant; now the two plants are controlled from a new control room attached to the new plant.

STRUCTURES

The No. 2 plant structure has been extended in this improvement program to include the third boiler

30,000 KW. ADDITION

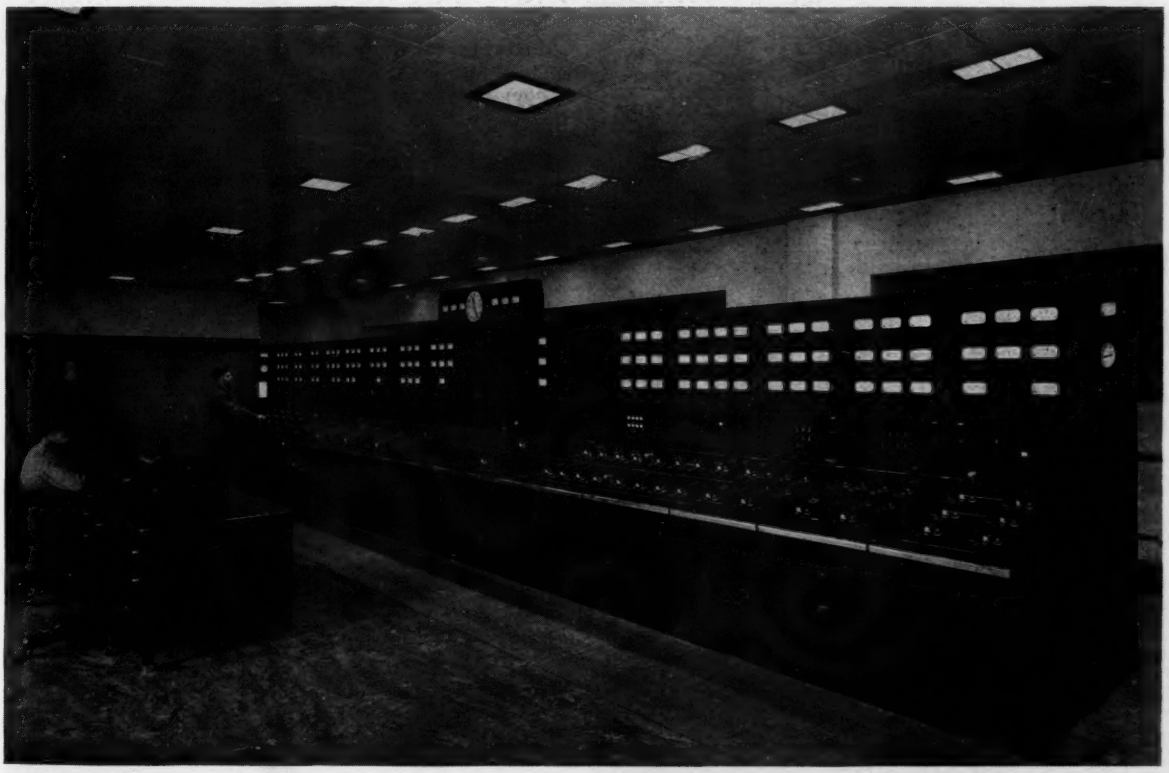
This is a description of the design and engineering features of the latest addition to Kansas City, Kansas, Municipal Electric Generating Station. Placed in operation with an initial 10,000 kw., this station now has 40,000 kw. capacity.

(No. 19) and space for the 4th boiler unit to be added at an early date. Between these two units is a 24 ft. bay which contains the deaerators and evaporators as well as a freight elevator and an enclosed stairway serving all turbine and boiler room floors. A large hatchway is provided in this bay so that present equipment located on the upper floors as well as future equipment may be serviced and installed with ease. A monorail hoist serves this hoisting well and the entire fan floor.

A two story annex was added to the outside of the boiler room. This annex is centered on the 24-ft. bay, which will be the center of the ultimate building, and is 90 by 20 ft. The grade floor (there is no basement) contains the boiler feed pumps. The second floor is at the level of the boiler operating floor and is used for toilet and locker facilities for plant operators with provision for future offices for the chief boiler engineer, fuel and water laboratories, and mechanical control center.

The turbine room has been extended the same length as the boiler room although the new turbo-generator requires but slightly over half the constructed length. Piles have been driven for the next (No. 8) turbine foundation. Sufficient space has been left between No. 6 and No. 7 units to allow No. 6 to be replaced with a much larger unit in the future without interfering with the second unit in any way.

Adjoining the turbine room and parallel thereto has been constructed a 5-story building to provide space for an entrance lobby, information desk and plant telephone operator's office, and station transformer room on the first floor; reactor and switchgear room on the second floor; main switchgear on the third floor; control room and offices of the plant superintendent and assistants on the fourth floor; and plant operating and engineering offices on the fifth floor. The control room, automatic telephone equipment room, and all offices are air conditioned for the comfort of employees and to help insure proper operation of control and automatic telephone equipment by eliminating dust and providing even, moderate



temperatures. Offices, halls, and control room are finished with terra cotta wainscoting, acoustical cork ceilings, and linoleum flooring. The main entrance lobby has walls of terra cotta, ornamental plaster ceiling, and terrazzo flooring set off by cove lighting. At the far end of the lobby and separated by an attractive grill is the plant telephone operator's room and information desk. A closed stairway and an automatic elevator serve the electric bay and the main turbine floor.

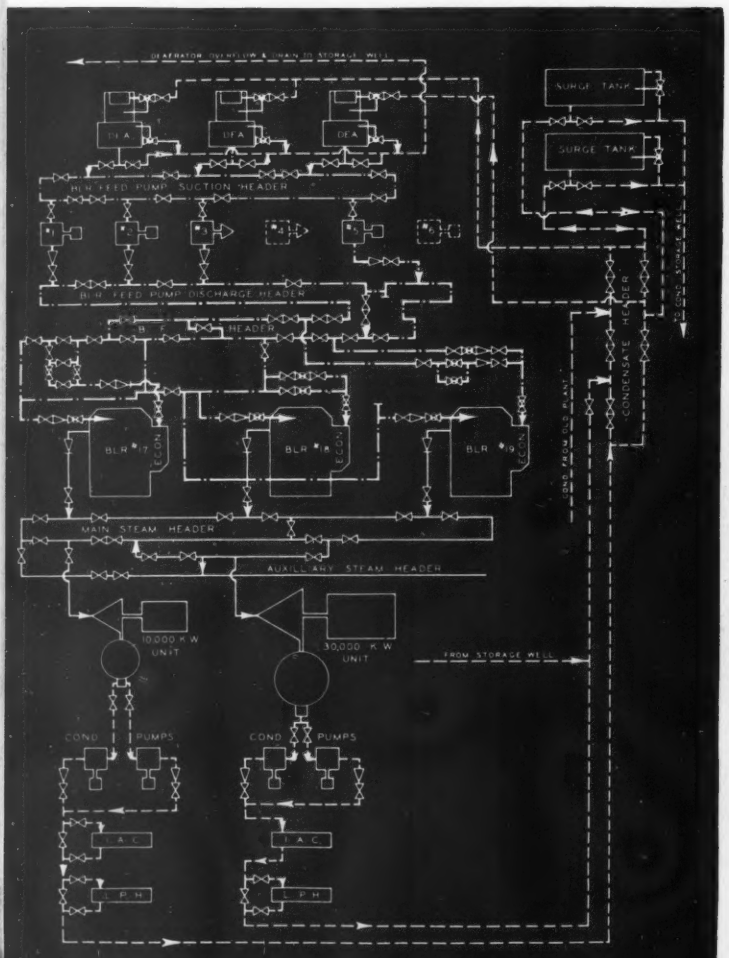
Reduced pressure low pressure steam properly desuperheated is used in unit heaters and concealed radiation to provide necessary heat in the electrical and turbine bays. Unit heaters are provided with fans and deflectors to direct the heat as required.

Steam Generator

The new steam generator is identical in most respects to the two previously installed units, having a continuous capacity of 150,000 lb. per hr. with a 4-hour rating of 180,000 lb. per hr. Steam is generated at 415 lb. per sq. in. and 700 to 750 deg. F.

This unit, No. 19, is equipped with hydraulic couplings and constant speed induction motors for driving the forced and induced draft fans rather than dual slip ring motors as used on No. 17 and No. 18 units.

Coal from overhead bunkers is weighed by automatic scales before it passes through feeders and into the pulverizers. Each of the two pulverizers serves two burners, the latter being squipped with automatic lighters designed to insure ignition under all circumstances. The two sets of fuel preparation and burning equipment are distinct and either set can carry a load of approximately 125,000 lb. steam per hr.



The furnace has water cooled walls and floor and is of the slag tap type. Bare and faced blocks are clamped to the tubes. Walls subjected to moderate and low temperatures are of suitable refractories and the entire setting is encased in sheet steel painted aluminum. The boiler is of the 4-drum type with interbank superheater. Economy is gained by the use of both a plate type air preheater and a return bend economizer.

Boiler control is of the semi-automatic type, although provisions are included for full automatic control when desired. One plain and one bi-colored water glass assure water level indication and a three element feedwater regulator maintains the level in response to load and level changes. Ashes are removed by an hydraulic system with slag disintegrators, sluiceways and ash pumps.

Turbo-Generator and Condenser

Number 7 turbo-generator is a 30,000 kw. unit turning at 1800 r.p.m. It is supplied with steam at nominal conditions of 400 lb. and 700 deg. F. TT. The generating voltage is 13.8 kv., with excitation supplied by a 125 kw. 250 v. exciter and 3 kw. pilot exciter direct connected to the main shaft. A turning gear insures proper treatment of the shaft. Oil coolers are in duplicate and are provided with valving to reverse water flow to clean the tube sheets of trash and needle ice passing the river screens and strainers. The generator air cooler is similarly valved and both the air and oil coolers are provided with emergency city water connections. The oil reservoir is slightly above the grade floor and the regular shaft pump and eductors are supplemented by motor and turbine driven oil pumps.

The unit is bled at three points and a fourth nozzle is blanked off for the present. Bleed steam is provided to evaporators, deaerators, and a low pressure closed heater, all of which except the low pressure heater are common to all units. Oil relay operated bleeder check valves protect the turbine where bleed lines are interconnected with other sources of steam.

The condenser maintains an average back pressure of 1 to 1½ in. Hg, the maximum and minimum vacua being indicated by water temperatures of 32 to 85 deg. F. The unit has a welded steel shell, cast iron water boxes, and Admiralty metal tubes. The 40,000 sq. ft. of surface is made up of 7640 1 in. by 20 ft. tubes. The tubes are rolled in at one end and are packed with metallic and fiber packing at the other. The water boxes are of the divided type for two pass operation. Each half of the condenser is served by a 36-in. inlet and similar outlet so connected that water flow may be reversed to clean the tube sheets and tube entrances. The usual atmospheric relief valve has been replaced by two rupture diaphrams and an automatic engine stop. The condenser is attached rigidly to the turbine exhaust and its load and the expansion load due to temperature differences is carried on four groups of heavy coil springs. Dual full capacity hotwell pumps

Fig. 4. Floor diagram of the complete station

Principal Equipment in 30 000 Kw. Quindaro Addition

GENERAL

Type plant: Municipal, Electric Generating Station.
Owners: Kansas City, Kansas.
Designing Engineers: Burns & McDonnell Engineering Company.

(1) BOILER ROOM EQUIPMENT

Babcock & Wilcox Company, 1—Steam Generating unit, steam pressure 410 lb. per sq. in. gage and total temperature 750°F. Normal capacity 150,000 lbs. steam per hour. Four hour maximum capacity 180,000 lbs./hr. Boiler heating surface 16 267 sq. ft.; interdeck superheater heating surface 5420 sq. ft.; return bend type economizer heating surface 1842 sq. ft.; Thermix plate type air preheater manufactured by the Prat-Daniel Corporation; heating surface 19,584 sq. ft.

Diamond Power Specialty Corporation Soot Blowers, 14 for boiler, 4 for economizer, 2 for air preheater (Prat-Daniel).

Babcock & Wilcox Company furnace of "Bailey" slag tap design with 1913 sq. ft. water cooled surface in 3½" tubes spaced 6".

Babcock & Wilcox Co. 2—Table type "B" pulverizers, capacity for operating boiler at 120,000 lbs. of steam per hour, operated by General Electric 100 hp. 2300 volt, 720 r.p.m. induction motors.

Babcock & Wilcox Co. 2—Drag type feeders with General Electric motor drive 2 h.p. shunt wound 250 volt d.c., speed control from 500 to 2000 r.p.m.

Babcock & Wilcox Co. 2—Exhausters overhung paddle wheel type driven by General Electric 60 h.p. 2300 volt, 1800 r.p.m. induction motors.

Babcock & Wilcox Co. 4—Cross tube forced draft burners.

Babcock & Wilcox Co. Automatic burner lighting system.

Richardson Scale Co. 2—Automatic coal scales, capacity 300 lbs. per discharge, 115 volt single phase motor drive.

Green Fuel Economizer Co. 1—Double inlet, single width, full housed induced draft fan equipped with hydraulic coupling American Blower Corp. 48" Class 1 driven by General Electric 250 h.p., 2300 volt, 450 r.p.m. induction motor.

Green Fuel Economizer Co. 1—Double inlet full housed forced draft fan equipped with hydraulic coupling American Blower Corp. 30" Class 1 driven by General Electric 150 h.p., 2300 volt, 1200 r.p.m. induction motor.

Consolidated Ashcroft Hancock Company Safety Valves for boiler, 3—3", for superheater, 1—4".

Diamond Power Specialty Corporation Water Column Forged Steel Hi-10 alarm and bi-color water level indicator with floor pedestal.

Bailey Meter Company Automatic Combustion Control, including control panel, steam and feedwater meters, draft gages, temperature and pressure recording instruments, three element feed water control.

(2) GENERATING EQUIPMENT

Westinghouse Electric & Manufacturing Company 1—1800 r.p.m. turbine driving a 37,500 kv-a. 0.80 p.f., 3 phase, 60 cycle, 13,800 volt a.c. generator, with a direct connected 125 kw., 250 volt, 425 amp. exciter and direct connected 3 kw. pilot exciter, and equipped with rotor turning gear. Steam conditions 400 lbs./sq. in. inlet pressure, 725°F. inlet temperature and 28½ inches vacuum exhaust pressure.

2—775 sq. ft. turbine oil coolers.
1—6240 sq. ft. generator air cooler.

(3) CONDENSER

Westinghouse Electric & Manufacturing Company, 1—40,000 sq. ft. two pass divided water box, spring supported surface condenser, with welded steel shell, 1" O.D. No. 18 B.W.G. tubes of Admiralty metal, 20' 0" effective length. Deaerating type hot well.

1—Double two stage ejector with separate inter and after condensers.

2—Two stage 660 g.p.m. 230 ft. total head, 900 r.p.m. condensate pumps each driven by a 75 h.p. 3 phase, 60 cycle, 440 volt squirrel cage induction motor.

(4) SWITCHGEAR

Westinghouse Electric & Mfg. Co.
Metal Clad Switchgear for 13,800 volt services. 8 Circuits requiring 13 metal clad units. Interrupting capacity of circuit breakers 500,000 kv-a. Ground fault bus protection.

Fig. 5. The main entrance lobby is dignified and impressive

3—Reactor metal enclosed compartments.
Metal clad busway for 2000 amp. capacity 37,500 kv-a. generator connection.

Main Control—16 panel bench board with mimic bus; vertical metal enclosed board controlling 2300 v. cubicles and 440 plant services—3 panels; vertical metal enclosed board controlling circuits from old plant, steam exciter panels, battery, and recording instruments—5 panels.

2300 Volt Cubicles—4 units added to existing 10 unit structure.

460 Volt Board—Main air circuit breaker board with removable breakers—8 units.

Neutral Breaker Cubicle, Resistor and 3 Reactors.

Material for modernizing and increasing interrupting capacity for 20 circuit breakers.

14—New circuit breakers completely replacing old breakers.

(5) STATION TRANSFORMERS

Westinghouse Electric & Mfg. Co. 3—933 kv-a. 13,800/2300/460 volt (460 volt windings for 100 kv-a., and 2300 volt winding for 833 kv-a.) transformers. Inerteen insulated.

3—100 kv-a. 2400/480 volt transformers. Inerteen insulated.

2—50 kv-a. 2400/120/240 volt transformers. Inerteen insulated.

(6) CONCRETE PILING AND EXCAVATION

E. A. Whitney & Son, Inc. & Jones-Hettelsater Construction Company. 5,720 cu. yds. excavation. 22,300 lin. ft. precast concrete piling.

(7) ASH AND SOOT REMOVAL EQUIPMENT

Allen-Sherman-Hoff Company, 2—Slag disintegrating chambers, approximately 80 lin. ft. sluiceway. 9—12"x4" Dust Valves. 1—4"x6" Hydrovactor. 1—Vacuum Breaker. Necessary Ashsolite pipe and fittings for connections.

(8) CIRCULATING WATER VALVES

Ludlow Valve Mfg. Co. 2—60" C. I. motor operated flanged O. S. & Y. double gate valves with by-pass and cleanouts.

2—42" C. I. motor operated flanged valves —ditto.

8—36" C. I. motor operated flanged valves —ditto.

(9) CAST IRON PIPE AND FITTINGS

United States Pipe and Foundry Company —Sizes 60", 42" and 36".

(10) STEEL PIPE

The Darby Corporation. Sizes 60", 42" and 36" with 6—60" Dresser Couplings, and 2—42" Dresser Couplings.

(11) BUILDING AND MISCELLANEOUS STRUCTURES

S. Patti Construction Company, Inc. Approximate cubic contents 2,500,000 c.f. includes turbine room and boiler room extension. 5 story switch room and office structure, and 2 story annex for boiler feed pumps and boiler operating use. Building on concrete piles with structural steel frame, concrete foundation and floors, brick walls, terra cotta trim, concrete slab roof. This contract also includes all equipment foundations and a separate structure to house a 60" valve.

(12) CLOSED HEATERS

Foster Wheeler Corporation.
1—Low pressure extraction heater with drip pumps, head type 1597 sq. ft. 150 lbs. pressure.
1—Evaporator for 50,000 lbs. per hr., approximately 8 ft. diam. x 15 ft. long.

(13) DEAERATING FEED WATER HEATER

Cochrane Corporation.
1—Deaerator for 250,000 pounds per hr., and 3—Storage tanks welded construction, 10'x8'x6' high, designed to support the heaters.

(14) BOILER FEED PUMPS

De Laval Steam Turbine Company.
1—Turbine driven boiler feed pump 800 g.p.m., 1190 ft. head, 1750 r.p.m. with 320 h.p. turbine, and 1—Motor driven boiler feed pump of same size, head and speed with 350 h.p. Westinghouse Type C.S. motor.

(15) POWER PIPING

Interstate Heating and Plumbing Company. Piping connecting all new equipment and with existing equipment, using Shutte Koerting non-return and bleeder valves, Chapman gate, globe and check valves, Edward forged steel valves, pipe fabrication by Midwest, Johns-Manville pipe covering, DuPont paints.

(16) POWER WIRING

W. T. Foley Electric Company. Wiring connecting new equipment and existing equipment, using Okonite wire and cable, and Westinghouse panelboards and starters and cubicles.

(17) LINOLEUM

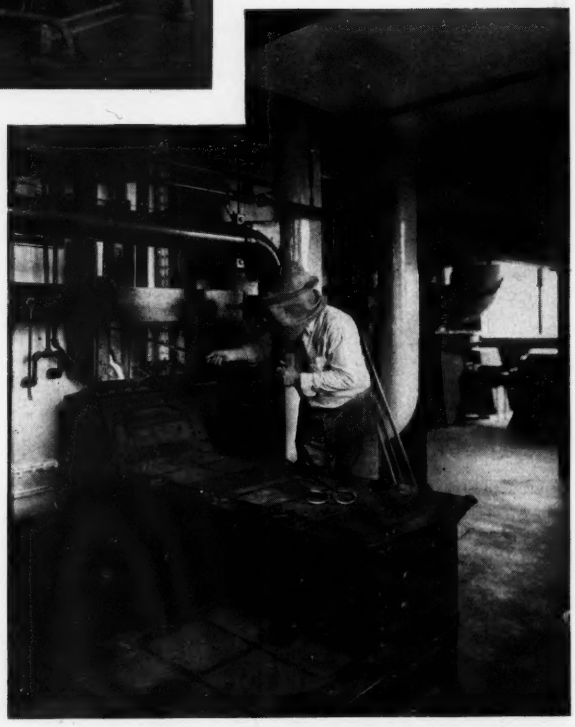
Kansas City Natural Slate Company. Floor covering for halls, offices and control room.

(18) PUBLIC ADDRESS SYSTEM

Graybar Electric Company.
2—Turret stations on turbines with 3—12" speakers each.
3—12" Loud Speakers.
2—Wall type station Western Electric Sea Sled Type.
1—Suspended Station with 2—12" Speakers.
6—Sets Microphones for return speech.
1—Main control.

Fig. 6. (Left) The 30,000 kw. generating unit represents over a half million dollars, installed

Fig. 7. (Below) Ash removal, 1939 style. It flows out



serve a full deaerating hotwell. A double two-stage air ejector with single pass inter-and-after condensers, using condensate, removes the non-condensible gases.

The turbo-generator and condenser unit is carried on a structural steel foundation having heavy concrete encasement. The operating floor is 32 ft. above the grade floor which in turn is 10 ft. above the 5 ft. thick pile cap. 187 precast concrete piles carry a total dead load of foundation and equipment of almost 5,500,000 lb. The space between the pile cap and the grade floor is walled off to form a 300,000-lb. condensate storage tank; removal of the condensate or boiler drainings is accomplished by two centrifugal pumps which can be connected in series to give a moderate hydrostatic test on the boilers.

Heat Balance

Condensate is deaerated and heated to 225 deg. F. by means of bleed steam and evaporator vapors (make-up). The condensate from No. 7 unit leaving the air ejector after-condenser at a temperature of about 90 deg. is heated in a low pressure closed heater to about 180 deg. at turbine full load. The heater contains 524—¾-in. tubes 15 ft. 6 in. long and is of the horizontal type. It has dual 14 in. steam inlets and is supplied with duplicate drip pumps that return the heater drips to the main condensate lines beyond the heater. All main condensate, except that required for recirculation through the inter-after condenser and condenser hotwell, is heated in this heater.

Two deaerating feedwater heaters purchased in 1930 were removed from their storage sections and relocated at the previously described new location where they were mounted on 10 by 10 by 6 ft. steel hot water storage tanks. These units are conservatively rated at 250,000 lb. per hr. each. A third unit of similar design was installed in this improvement program. The three units, with provision for a future fourth unit, are served by steam and condensate headers of the ring type and they discharge into a ring header serving the boiler feed pumps. Steam pressure is regulated in the deaerator steam headers by two identical butterfly valves. These valves were chosen to secure desired regulation with minimum pressure drop when initial pressures were low. Either valve may be isolated without interferring with steam supply from any turbine to any deaerator. Overflow is discharged to the condensate well under the turbine foundation. The deaerators will operate on sub-atmospheric pressures whenever necessary, although design is such that saturated temperatures of 225-226 deg. F. can be maintained most of the time.

Two surge tanks are located on the roof of the boiler room. Each is designed to accommodate two deaerators, although they are normally operated in parallel. The tanks are 7 ft. in diameter by 48 ft. long and are supported at two points only.

The new and principal evaporator is a 50,000 lb. per hr. unit installed on the fan floor and arranged to generate vapors from unpreheated soft water (hot process) at approximately 7 psi gage. High pressure bleed steam under hand throttling is used as heat although the unit is so connected that it can be supplied with vapors from an existing evaporator (double effect) or direct from the 400 psi live steam headers, main and auxiliary. The latter steam is used for cracking scale in this unit. A duplicate evaporator will be installed in the future at such time as the

No. 1 plant is reduced to a cold station, at least so far as the boiler room is concerned. At present a large part of the evaporation requirements is met by the old plant boilers as an aid to their operation.

Four identical boiler feed pumps are installed in the pump bay, three of these units are motor driven and the fourth has a steam turbine drive. It is used only for emergencies and consequently exhausts to atmosphere. Provision has been made for the installation of another motor driven and another turbine driven boiler feed pump. Each pump delivers 800 g.p.m. at a TDH of 1200 ft., the minimum suction head being based on a static head of some 37 ft. plus steam pressure in the deaerator.

City water used for make-up is treated in a hot process water softener, evaporated, deaerated, and given supplementary treatment with sodium phosphate as needed under the Hall system and the direction of the plant chemist. Many samples of water are taken daily throughout the plant to insure accurate knowledge of water conditions throughout the system.

Piping and Instruments

All piping is designed in accordance with Tentative Power Piping Code supplemented by additional requirements. All high pressure lines and most low pressure lines are welded except at valves and connections to equipment. Schedule 60 seamless Grade "A" pipe is used on high pressure lines; series 40 steam valves are used on main steam and series 60 on boiler feed lines. Practically all check valves are of the tilting disc type. Turbine and boiler lead gate valves and circulating water valves are equipped with torque limiting motor operators. Stainless steel trim is used on high pressure valves and stainless steel stems have been used on some low pressure valves. Bare and insulated pipes have been painted in accordance with a previously used color code based on the A. S. M. E. suggested code. Paint is of the type having a synthetic vehicle.

The piping system is laid out for maximum reliability since this plant will eventually become the only plant on the system. The layout is such that the ultimate plant can be operated as two separate and distinct plants. Whether operating as one or two plants, the piping system will present in so far as the main services are concerned a layout having ring headers and double sectionalizing valves. Steam velocities have been kept to conservative values of 10,000-12,000 f.p.m. and water velocities to comparable values. Expansion stress and thrust were determined graphically as described by Mr. C. T. Mitchell and these results were checked by other methods suggested by various authorities. Total bursting and expansion stresses have been limited to 10,000 psi and thrusts have been maintained at low values. Cold springing has been used on all hot lines with definite control provided by substantial anchors.

The accompanying prints indicate the essential piping.

Electrical Control

Inasmuch as five generating units are still in the old plant and only two in the new plant, the control scheme had to be planned for the ultimate development yet made to fit in with present demands. A synchronizing bus scheme with duplicate main buses with single synchronizing bus, as shown on the one line diagram, was adopted.

The main switchgear structure consists of 13 units of 13,800 v. vertical lift type metal clad switchgear with built in lifting motors. Rupturing capacity is 500,000 kv-a. Phase isolation is carried out throughout the entire structure. Ground fault protection is obtained by insulating the various switchgear sections from each other and from ground and grounding through 1000/5 amp. current transformers. This gives protection all the way from the bus to the regular current transformers which provide the normal protection from that point on. The normal protection for generators, station transformers, and plant tie cables is differential protection while for feeder circuits it is over current protection.

A new 16-panel steel benchboard controls the seven generator and main bus circuits in both plants. Two vertical enclosed steel cubicles control station auxiliary circuits, one for each plant. The moving of control circuits required very careful planning and scheduling of work to avoid interference with operation. Two railroad switchtracks which are in daily use to bring in the station's coal supply run between the two plants and large circulating water lines also intervene. The many control cables necessary had to be carried under these and were installed in steel conduits encased in reinforced concrete. Fifty conductor control cables were used.

One unique feature which was installed is a two-way public address system between the control room and the turbine and boiler room in both the old and new plants. This system is the normal means of dispatching orders to the turbine and boiler room. In addition, the old Selsyn signal system and an intercommunicating telephone system is also available.

Station auxiliaries in the new power plant are either 2300 v. or 460 v. Three sources of power supply are available for 2300 v. service and two for 440 v. service. One source of power is from a bank of 3—933 kv-a. three winding transformers; one 460 v. supply is from the three winding transformers, the second is from a bank of 3—100 kv-a. transformers supplied from the 2300 v. buses. These station transformers are all filled with a non-inflammable insulating medium and therefore vaults and partitions were unnecessary in the first floor of the switch house where they are located.

It was found necessary to increase the rupturing capacity of circuit breakers on the 13,800 v. bus in the old plant by adding deion grid contacts and making other changes. However, the 2300 v. bus breakers all had to be replaced; this was done by removing the center phase barrier between breaker tanks in the old concrete structures. Reactors were installed on circuits feeding 2300 v. groups to limit short circuit current on breakers feeding from group buses.

The new generator and main switchgear buses were connected by metal clad 2000 amp. 15 kv. busway. It was used from generator terminal to buses and the

Continued on Page 441

COMBUSTION

By
RICHARD H. MORRIS
Engineering Editor

HIGHLY DEVELOPED commercial combustion control is relatively new. Its application has not been, and probably never can be, completely standardized for new equipment and arrangements are constantly being developed to meet the changing and varied demands of modern plants. There has, however, been a concerted effort by manufacturers to reduce the earlier and sometimes unduly complicated equipment to simplified and standardized controls, sufficiently flexible to meet the specific needs of a wide range of plants.

Only in this way could the cost be brought to a point where effective combustion control ceased to be an operating luxury of the large central station and became an economic necessity for even the smallest industrial plant. It was early recognized that, if the equipment was to accomplish this purpose, it had to be sensitive, powerful, rugged and adaptable in principle, capable of meeting the simplest needs of the small plants and the most complicated needs of the large plants.

The Control System Itself

How successful manufacturers have been in solving this difficult problem has been told in a series of articles[1] recently completed. Different manufacturers solved the problem in different ways yet all arrived at similar solutions: standardized control and power units, susceptible to numerous combinations, coordinated in such a way as to maintain the desired furnace pressure and to regulate the supply of fuel (or fuels) and air in proportion to the steam load in a predetermined relation to each other.

With a few notable exceptions, such as the Benson boiler under variable pressure operation, it is customary to operate boilers so as to maintain approximately constant steam pressure at the header. Changes of pressure from this normal value are generally taken as a primary indication of the steam load or demand. The steam pressure acts directly on a master controller or steam pressure regulator which in turn sends a controlling force of some kind to: secondary regulators; power operating units; or directly to final regulating devices such as dampers, valves or speed changers. This controlling force may be air, oil, or water under pressure, cable, shafting or electricity and the same or a different medium may be used to operate the power unit.

The Plant to Which It Is Applied

The simpler controls which developed from the early damper regulator, have been subjected to constant refinement and continue to meet the needs of the small boiler where centralized control is not required by physical size alone. In accordance with industrial trends and the increasing size of boilers in the larger plants, there is, here, however, a tendency to group all control elements at a central point or panel with the power elements at the dampers, motors, or valves to be moved.

But the equipment itself is only half the story. The very newness of combustion control, the lack of experience in its application, often leaves the plant designer

[1]The articles referred to, describing the principles of operation and details of construction of the commercial combustion control equipment, started in the February, 1935, issue of Power Plant Engineering and ran consecutively through September, 1936. A final article appeared in February, 1937.

CONTROL SPECIFICATIONS

Part I. Specifications should tell definitely and concisely: What is wanted; physical limitations which must be met; and, conditions under which a contract will be awarded. Inasmuch as they later become part of the contract itself, they have a quasi-legal status which the engineer, treading on unfamiliar ground, distrusts. ¶ As a result, specifications, like heirlooms, tend to be hoarded, passed down from generation to generation and from industry to industry with a strict taboo on major alteration until they become so encumbered with irrelevant detail that the original purpose is lost sight of. ¶ Modern combustion control, an outgrowth of the simple damper regulator and the early custom built systems, is relatively new and only of recent years has it assumed the status of major equipment in plants of all sizes. Unhampered by tradition and unencumbered by precedent, the industry has grown so rapidly that adequate specifications have been prepared by only a few companies. ¶ This chaotic condition prompted the preparation of standard specifications in an endeavor to bring buyer and seller together on a common ground, for if control is to be reduced in cost so that it may be extended to its ultimate scope, requests for bids must be accompanied by specifications which give complete information with service requirements sufficiently broad to allow free competition yet definite enough to insure comparable equipment. ¶ Part I deals with the fundamental requirements of specifications. Later sections will deal with the control problem as a whole; its relation to equipment in the plant; and typical specifications for modern boiler plants.

in a quandary. This tends to create a condition in which control is often left till last and then given scant consideration either from the standpoint of plant design or specification. As a result the specifications often are: closely written so as to limit competition; too brief without adequate information for an intelligent bid; or, impossible to comply with.

Last, but not least, it may be found too late that the major equipment selected is not susceptible to control within the limits desired. No control can correct load or efficiency conditions set by natural limitations of the major equipment, and which could not be corrected manually by an operator. Automatic control cannot accomplish the impossible, its advantage lies in an unfailing ability to follow load changes quickly and rapidly and to maintain predetermined conditions at all times.

Like other equipment, combustion control is expected to pay its way and cost is an important factor Adequate specifications enable manufacturers to reduce sales expense commensurate with reduced manufacturing costs and so make the full effectiveness of combustion control available to the power plant industry.

What Specifications Should Cover

Specifications in a new field are always troublesome, however, so Power Plant Engineering has undertaken the preparation of standard combustion control specifications as a sequel to the series of articles[1] previously mentioned. In general, the intention has been to make these specifications broad enough to cover all combustion control systems, yet, sufficiently complete and detailed to set forth the specific requirements of the plant and give all data necessary for a manufacturer to submit a complete proposal with minimum expense, and, on equipment comparable to that offered by others.

The specifications themselves should answer three questions: First, what is the equipment to be controlled? Second, what are the special conditions of time, future additions, power supply, load, etc., that must be met? Third, what is the control expected to accomplish? They should: be limited to points that have a real bearing on the question in hand; be concise, definite and complete so as to require or allow no expression of opinion on their interpretation; deal with quantities or tolerances capable of test or measurement preferably by standard or generally recognized methods.

As to the boiler and auxiliary equipment to be controlled, we must assume: that it will perform as intended; that the heating surfaces are adequate to deliver the maximum output at the desired steam conditions; that the fuel supply and heat release are sufficient to carry the maximum load safely; that proper combustion conditions can be maintained at the desired maximum and minimum rating; and that the fans, dampers and ducts will handle the necessary quantities of air and flue gas over the desired range of load.

With these assumptions, complete data on the equipment to be controlled, and the desired extent of the control features, the design of the control system reduces largely to a matter of experience in selecting the combination of control elements best suited to the auxiliaries, dampers and valves used.

Actually the assumption that the equipment will perform as intended is often overly optimistic and cannever be taken for granted by the control manufacturer. The plant designer in selecting equipment must bear in mind that each piece of equipment must not only operate, but that it must operate successfully in conjunction with other equipment under widely varying conditions. Most control difficulties develop

through deficiencies in the equipment it is applied to.

Special conditions which should be covered are difficult to classify but should include: the time and place proposals are due; number of copies needed; engineers' status; alternate proposals; service and load conditions of the power plant; power available; provisions for erection; terms of payment; shipping instructions and any special clauses which individual companies sometimes incorporate in specifications of all kinds.

What the Plant Engineer Must Decide

Beyond the fundamental and primary purpose of regulating the fuel and air supply and gases of combustion automatically in accordance with the steam load, the desired excess air and the desired furnace pressure, the modern control is susceptible to an infinite variety of automatic, semi-automatic and remote features, limited only by the needs of the plant and the money available. Only the plant designer can answer this properly and that answer should form the basis of the specifications.

Due to the confusion which now exists in the control field, of which combustion control is but a small part, a definite effort has been made to avoid any attempt at standardization of terminology. Nomenclature and phraseology are too involved to be treated lightly and their importance warrants the rather belated action recently started by a special sub-committee on Industrial Instruments and Regulators organized under the Process Division of the A.S.M.E.

Clarity, however, demands that certain terms as used later in a narrow sense be defined. These are, admittedly, defined more or less arbitrarily, and to avoid partiality, with major consideration given to the dictionary in cases where current usage tends to be unduly influenced by trade names coined by manufacturers. The several terms defined in accordance with their use in this series of articles are: specification; control; regulate; automatic combustion control system; automatic, semi-automatic control; remote, direct and manual operation.

When it is realized that the range of automatic combustion control extends from a small single boiler plant needing only furnace, fuel and uptake damper regulation, through the larger industrial plant with many special problems and perhaps two fuels, to large high pressure, high temperature, multi-boiler central stations where combination damper and fan speed, fuel flow and furnace pressure must all be coordinated, it is easy to appreciate that the outlining of adequate specifications is beyond the capabilities of any one individual and must, of necessity, be the unified efforts of the industry: operators, designers and manufacturers.

Acknowledgment of Assistance

Dozens of engineers from all groups and from all parts of the country cooperated wholeheartedly with suggestions during the formative stages, and, with criticism of the manuscript during the final stages of the project and their assistance is gratefully acknowledged.

SOME TERMS AS USED IN CONNECTION WITH COMBUSTION CONTROL EQUIPMENT

and Approved by the Combustion Control Committee of the Scientific Apparatus Manufacturers of America

Specification

Specification is commonly used in the plural form and in the sense used here is defined by Webster as "A written or printed description of work to be done, forming part of a contract and describing—mode of construction, and also giving dimensions and other information not shown in the drawings." For the purpose of these articles, "Mode of Construction" refers specifically to the plant and its auxiliaries and not to the details of construction and method of operation of the control equipment. It is necessary to recognize the specifications as included in the final contract consist of two parts: first, those of the purchaser (under discussion here) telling what is to be done; second, those of the control manufacturer telling how, and with what equipment, it is to be accomplished. In the second case "mode of construction" would refer to the principles of operation and details of construction of the control equipment itself.

Control and Regulate

No attempt has been made to differentiate between Control and Regulate so that in general all forms of these two synonyms must be considered interchangeable. It is, however, common in combustion control practice to speak of a "master" control or controller, as the device which measures the change of steam pressure[3] and exerts a parallel influence over several regulators[4] or controllers. These act through power operating units to move dampers, valves or speed changer, and regulate the fuel, air and flue gas in accordance with predetermined relationships.

Master control or controller as used above is a single piece of equipment. To be consistent "regulator" (or controller used without master) should be considered a single piece of equipment but this is not entirely practical because commercial designs sometimes do, and sometimes do not, include a power operating member built integral with the measuring instrument. Therefore, in the interest of clarity "regulator" or "controller" when used in these articles without further limitation are considered to include the regulator proper or measuring instrument and the power operating unit. In addition, operation presupposes necessary connections to the valve, damper or piece of equipment to be moved.

Automatic Combustion Control (System)

In connection with automatic combustion control, the word "system" is popularly used in the sense defined by Webster as "a group of diverse units so combined . . . as to form an integral

[2]These interpretations of several terms to be used in this series of articles were formulated by POWER PLANT ENGINEERING with the cooperation of prominent engineers and combustion control manufacturers and have been approved for this service by the Combustion Control Committee of the Scientific Apparatus Manufacturers of America. They are not advanced as rigid definitions but as more or less general functional outlines to explain the terms as they are used in the articles and to serve as a base for further work on standardization. They are concerned solely with the narrow field of automatic combustion control. While it has been recognized that, due to the small number of manufacturers involved, the needs of this limited field are more easily met than the general needs of the entire control industry, a definite attempt has been made to avoid conflict with fundamental and theoretical definitions intended for the control industry as a whole. A number of tentative definitions advanced, by the Terminology Subcommittee of the Industrial Instruments and Regulators Sub committee organized under the Process Industries Division of the A.S.M.E., appear in italics in other footnotes.

[3]From the standpoint of the boiler as a unit the only independent variable is the steam load or steam flow. This is not utilized directly by the controller, however, for the control force is taken from the steam pressure which is a direct measure of the balance between steam demand and heat release. The steam pressure is, therefore, the "measured variable" which has been adequately defined in general terms as *"that quantity or condition which is measured by the automatic controller."*

[4]*"An automatic controller or regulator is an apparatus which measures the value of a quantity or condition which is subject to change with time and operates to maintain within limits this measured value."* This includes the measuring element or regulator proper, the power operating unit or units, all connections and the valves, dampers, etc., by which "this measured value" is maintained.

whole," that is it includes all equipment needed to accomplish the desired results. Use of "system" in this way conflicts with the theoretical definition of an "automatic control system"[5] and to avoid confusion in future standardization work, "system" as used first above has been abandoned for the simple "Automatic Combustion Control" in which the popular conception of system as "an organized whole" is inferred.

Thus an "automatic combustion control" refers collectively to all parts or equipment needed to accomplish the results set forth in the specifications for automatic, semi-automatic, remote or direct operation. This simplification avoids the anomaly of classing as a "system" a combination of equipment which technically may be nothing more than a simple controller or regulator.

Due to the fact that manufacturers do not ordinarily include standard connections, an automatic combustion control as sold may consist of anything from a set of disconnected regulators to all the parts and connections assumed above for complete operation. Special parts or connections necessary are usually included but standard shafting, pipe, wiring, cable, conduit, etc., is not.

An element such as the furnace pressure regulator, normally without direct connection to the master but dependent upon it and considered necessary to coordinated action, is part of the automatic combustion control. The feedwater, feed pump, excess pressure, steam temperature and other regulators may or may not be considered as part of the system depending upon whether they are directly tied in with the combustion control through the master loading or through one or more of the main regulators. Obviously the more general term boiler control would include not only these but all control and regulator elements of the boiler, auxiliaries and appurtenances, regardless of their relation to the automatic combustion control system under specific discussion here.

Methods of Boiler Operation

The following terms make provision for several definite methods of boiler operation: (1) where both the heat release and fuel-air ratio are controlled automatically in accordance with the demand for steam; (2) where only the fuel-air ratio is controlled automatically with the heat release or steam output controlled manually; (3) and two degrees of manual operation, neither of which involve automatic control beyond that provided by the furnace pressure regulator which is assumed in all cases where forced draft is used. Provision for several types of operation can be, and usually is, provided on automatic combustion control systems, but there is no standard practice and details vary with the system chosen and with the needs.

Automatic Control

Automatic control means complete operation of the boiler and auxiliaries within specified limits and in accordance with the steam load without assistance of the operator. Thus an air supply system using two-speed motor driven forced draft fans with auxiliary dampers might be designed so that the automatic control actuated only the dampers leaving the change in motor speed to the discretion of the operator. Insofar as it performs its intended duty of properly handling the dampers within the load range intended, the control system would be considered automatic. Obviously, however, if the equipment has been purchased to handle both operations automatically, it would not be performing its full function if for some reason one of the two had to be made by manual or remote means. By the same token, providing means for manually changing the number of burners or mills in operation would not invalidate the automatic classification within the limits specified for automatic operation.

Semi-Automatic Control

Semi-Automatic Control is a limited form of automatic control in which the will of the operator is substituted for the automatic action of the master controller, but, without disturbing the coordinated operation of the different regulators in automatically maintaining the fuel-air ratio and furnace pressure. Semi-automatic control utilizes the master loading or control lines, regulators and power units of the automatic combustion control system with the master loading set or adjusted by the operator. Thus a boiler on semi-automatic control operates at constant or base load subject to change by the operator. Deprived of the automatic coordination between regulators, and carried to the ultimate with individual positioning of each regulator, semi-automatic merges into the remote classification and requires manual operation.

Practice has not been standardized and the degree of flexibility varies with the system used and with the plant requirements. In general in multi-boiler installations, any boiler or boilers may be shifted to semi-automatic control at one point and adjustments to, or between, individual regulators on a given boiler, made at a different point which may or may not be on the same panel. Provision to change the ratio between two variables such as fuel and air, while generally provided with automatic combustion control equipment (by automatic means or manual adjustments at the panel, at the regulator or at some intermediate point) is not in itself considered as semi-automatic control nor as a requisite of semi-automatic control.

In the past this type of control has been variously known as manual, remote manual, individual automatic, base automatic, base load automatic, and base load control. "Semi-automatic" was adopted to give an element of standardization without favoring any individual manufacturer and at the same time avoid confusion with "manual" and "remote" operation.

Remote Operation
Remote Control—Remote Positioning

Remote Operation (or Control), in accordance with usage throughout all branches of engineering is considered as the ability to move, control or operate, manually and separately, any piece of equipment from a given distant point or points by push button, loading lines or other means in a definite or infinite number of steps. Provision for remote operation is often incorporated in the combustion control system to extend the semi-automatic features, to provide convenient means for manual operation and to facilitate placing the boiler in, or taking it out, of service from the panel board. It may be built as an integral part of the automatic control system or, partially or completely independent, in which case the two may or may not be operated simultaneously as component parts of the same system.

As distinguished from the semi-automatic features of an automatic combustion control system, the remote operation feature means facilities for the separate manual adjustment, from some point usually on the control panel, of any piece of equipment normally operated automatically by a regulator (furnace pressure regulator excepted). Due to the difference in operating principles of the different combustion control systems, two methods of remote operation must be recognized. These have been arbitrarily called "remote positioning" and "remote control". In the first case, "remote positioning", of which the push button type is typical, the damper or other piece of equipment may be set or positioned positively and independently of the position or effect of any regulator or other piece of equipment in the system.

In the second case, "remote control", the piece of equipment may be positioned but the position is conditional upon the action of other parts of regulators in the system, as for instance where the remote loading to a regulator is balanced by a so-called metered indication. Because of the effect that the movement of another element in the system may have on the regulator through the metered connection, it is often difficult or impossible to distinguish remote control of this type from semi-automatic control. The difference may not be important in actual operation depending upon the arrangement and details of equipment and the results desired. It is more likely to be important at extremely low loads and while starting.

Direct Operation

Direct Operation (or control) means the movement of any damper, feeder, auxiliary or other device directly affecting the operation of the boiler or auxiliaries, by the operator, utilizing no part or element of the control system with the possible exception of cables or rods directly involved with a given regulator and attached to the part to be moved, and, with no source of power beyond a rack and pinion, handwheel or lever to give the necessary mechanical advantage. This usually requires the opening of a bypass or mechanically disconnecting the power unit of the automatic control system and is provided to allow manual "operation" of the boiler when the control system is out of operation. When loading lines or power cylinders are used, the action becomes either "remote control" or "remote positioning".

Manual Operation

Manual Operation means that the operator uses no coordinated automatic controls (furnace pressure and feedwater regulators are considered as operating independently in this case) and moves the dampers, valves, feeders and speed changers, "direct", or, in the case of large boilers, "remotely", or, by a combination of the two.

[5] *"An automatic control (regulator) system is a combination of two or more automatic controllers acting together to maintain within limits the value of a single designated variable."*

Modernization of Paper Mill

By
K. R. WARRINGTON
Francis J. Sill, Consulting Engineer
Westboro, Massachusetts

PROBABLY no manufactured article is more universally used than paper. Its uses are many and varied, since it is required, in one form or another, in the home, the factory, the office and the school.

The power required to manufacture various types of paper is affected considerably by the particular equipment in the mill and also by the technique in operation in each mill. In this article, we will not concern ourselves with the different processes through which all types of paper must go before they become finished products, but will direct our attention to the source of the power needed by paper mills.

As water is a major item in the processing of paper, the mills are usually located along waterways, which in olden times were the only source of power. The development of the steam engine and electric power were responsible to a great extent for the growth of the paper industry, and at the present time the manufacturer is able to obtain power from water-wheels and turbines, steam engines and turbines, Diesel engines and public utilities.

The prime requirement in the power service of a paper mill is quality and continuity of service. Economy in cost is important only after an uninterrupted supply of power of even voltage and frequency is assured. Even momentary failure of power for driving the paper machines themselves is very expensive and usually the power for driving these machines is obtained from a power plant located at the mill, in order to avoid the interruptions and disturbances inherent in long transmission lines and cables exposed to lightning, sleet, floods, hurricanes, etc. No one type of power generating equipment is universally applicable, although each type can be justified under certain conditions and requirements. The selection of power equipment should be made as the result of a comprehensive survey of the particular mill or mills involved, by an engineer specializing in this type of work. It is economy to install dependable equipment which gives the lowest cost per horsepower, including in that cost the charges applying to the investment. The savings to be realized from the installation of high efficiency power equipment in existing plants is usually not sufficient in itself to justify the discontinuance of reasonable efficient, adequate and serviceable equipment. However, many paper mill power plants are now operating that contain equipment which is due for replacement owing to its length of service. In such cases, only the additional cost of the higher efficiency equipment over that of straight replacement is chargeable against the savings.

The flexibility of power plants for most paper mills should be very great, because manufacturing conditions and processes are changing and will change from time to time and what has been accepted as a condition for design may be altered a few years later. The choice between engine, turbine or motor drives for paper machines must be based on a study of the overall economies of the drive in connection with speed range and tonnage at various operating speeds. In general, it will be more economical to use variable speed turbines or adjustable voltage, direct-current motors to drive general purpose paper machines if the power supply is obtained as a by-product of steam required for process.

Steam is required at low pressure up to 40 lb. and high pressure up to 140 lb. for the manufacture of paper. The diagram, Fig. 1, shows the typical paper mill departments that require power and steam for process. Steam is also required, of course, to heat the buildings during cold weather.

THIS IS THE second in the series of articles devoted to the modernization of power plants in various industries. The first, a 3-part article on textile mill plants appeared in the February, March and April issues. Now we present this one devoted to power plants serving the paper industry. In few industries are the power and steam requirements so essential or so important as in the manufacture of paper. From the grinding of wood for pulp to the final finishing of the surface, power and steam is used in every phase of the process. The cost of power production is therefore a vital element in the final cost of the product. In view of these facts we deem it a privilege to present this article by Mr. Warrington. Both Mr. Warrington and Mr. Sill have had wide experience in the paper industry and the analysis of conditions in the paper industry with respect to power should be of value to industrial plant operators in other fields as well as the paper industry.

Power Plants

The turbine room at a central power plant supplying steam and power to five paper mills

The amounts of power and steam required for various paper mills depends on the stock used as listed below:

PAPER STOCK

1. Refuse.
2. All ground wood. Low percentage of sulphite.
3. High percentage of sulphite. Low percentage of ground wood.
4. All sulphite.
5. High percentage of sulphite. Low percentage of rags.
6. All rags.

The majority of paper mills operate 24 hr. per day with comparatively even demands for steam and power during the entire period. These high load factors steam and power demands are ideal for the operation and generation of power at low cost by an industrial power plant.

WATER-WHEELS AND TURBINES

Many of the original paper mills in this country are in operation with the old water power developments still in use, although few such plants have sufficient capacity to furnish all power required by modern methods of manufacture or to generate continuous power due to variation of water flow. However, many paper mills obtain a considerable amount of power from water, which must be taken into account in connection with new power developments. The total cost of a new hydro-electric development, including flowage rights, dam, basin, penstock, water turbines, etc., is generally several times the cost of installing the same capacity of other types of generating equipment so the savings in fuel are more or less offset by the additional investment charges.

STEAM ENGINES AND TURBINES

In a straight condensing plant, such as a public utility, it is desirable to use steam at as high a pressure and temperature as available materials and equipment will allow. However, in the paper mill power plant, the situation is quite different, because a considerable amount of steam is required for paper mills, depending on the type of stock that is processed. This condition permits generating steam at a sufficiently high pressure and temperature so that it can be expanded through steam engines or turbines to generate by-product power and then exhausted and extracted at the desired pressures for process work. Thus, nearly all the heat in the steam can be utilized and the power obtained very economically. By using the heat in the extracted or exhaust steam for process, a material economic advantage is gained over the usual condensing power plants where at least two-thirds of the heat in the steam is lost in the condensing water. The installation of reciprocating engines in connection with high pressures and temperatures prevalent today is limited and will not be considered further in this article.

Boilers and turbines, from the smallest to the largest size required in the paper industry, can be obtained for high-pressure, economical operation. Turbines require no internal lubrication and the exhaust steam is free from contamination. The ratio of power used to steam per pound of paper is not fixed. It varies with the process, the sheet, the method of drying, the atmosphere, and the season of the year. The initial pressure and temperature, at which steam in a power plant of this type should be generated, depends on the amount of power and the amount and characteristics of the steam required for process. The steam should be generated at a pressure and temperature in order that the exhausted and extracted steam from the turbines during power requirements will exactly supply all steam required for process. Unfortunately, it is very unusual that a condition approaching such an ideal balance can be maintained. This is theoretically possible for a complete new mill and power plant, but would not remain so for any great period. Generally, the problem of high pressure and temperature arises in connection with additions or replacements of present plants. In other than very exceptional circumstances, the turbine throttle pressure and temperature for paper mill power plants should not exceed 800 lb.—750 deg. F. (total temperature) based on present day economical practice. Normal carbon steel may be used up to this temperature with designs and dimensions based on usual stress limits.

The curves in Fig. 2 show theoretical turbine steam rates for various initial steam pressures at

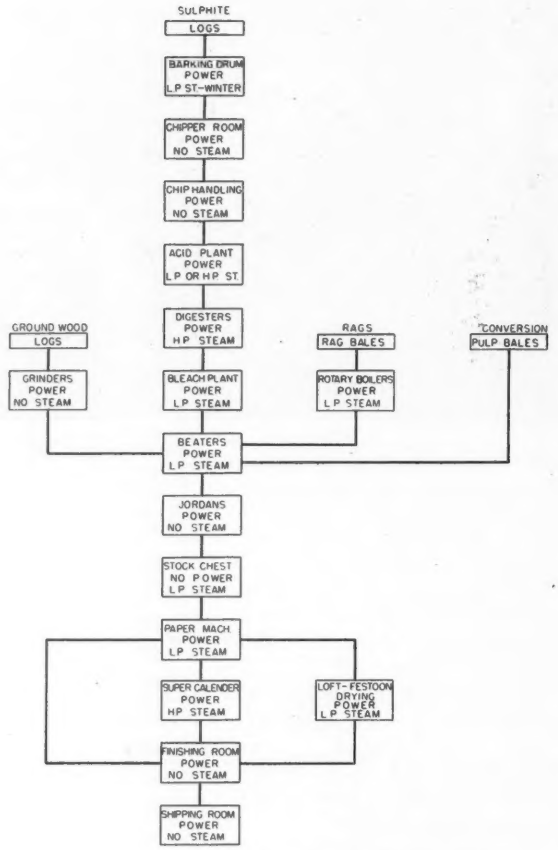


Fig. 1. Paper Mill Power and Steam Requirements

750 deg. F. and different exhaust pressures. These ideal rates would be increased in operation in accordance with the load on the turbine and the corresponding Rankine cycle efficiency. However, the curves are suitable for comparative purposes and show that the rate of return from increased pressure is limited as follows:

a. With each uniform increase of initial steam pressure, the resulting percentage reduction of the turbine steam rate becomes less.

b. The percentage reduction in the turbine steam rates, due to increases of initial steam pressure, is much less in the lower exhaust or extraction pressure range.

In short, high initial steam pressures can be used to better advantage for conditions where high exhaust or extraction pressures are necessary.

Equipment for moderately high-pressure steam has been in operation for a sufficient time to establish the fact that it is very dependable and that it is fully as safe as equipment for lower pressures. The replacement of old boilers with modern, efficient, steam generators, fired with pulverized coal, stokers, or oil, will generally justify the expenditure for this particular equipment by fuel savings. The efficiency of a steam turbine falls off rapidly with the lesser ratings and the higher pressures. Therefore, the installation of small capacity, high-pressure turbines is more difficult to justify than larger units, in view of the fact that turbine costs increase with pressures and temperatures.

In many cases the steam required for process is at two or three pressures and in quantities not in accordance with the demand for power. Process steam may be extracted after partial expansion in the turbines or the expansion in the high-pressure turbine may be ended at the highest pressure of process steam and part of the exhaust used for process and the remainder discharged to present low-pressure turbines or reciprocating engines.

If the power requirements at times exceed the amount that can be generated with the quantity of steam required for process, the remaining power can be supplied by expanding part of the steam to condensers or by obtaining the additional power from other sources. In case the demand for process steam is greater than that being exhausted and extracted from the turbines, the additional steam could be obtained from pressure reducing valves and desuperheaters. A portion of the high pressure steam would then be by-passed through the pressure reducing valves and desuperheaters during these periods without losing any appreciable amount of the total heat of the steam. The operation of this equipment under all conditions should be automatically controlled.

It is very important that the selection of initial steam pressures and temperatures and the type of steam and power generating equipment should be made in conjunction with the manufacturer in order to avoid the higher cost of specially designed equipment.

It is safe to say that it pays to generate power at least up to process steam requirements in paper mills where there is a moderate or considerable demand for process steam. The greatest savings effected by the operation of modern high-pressure equipment in paper mill power plants is due to increasing the amount of power that is generated as a by-product of steam for the mills and thereby reducing power that is obtained from condensing or that is purchased.

It is seldom that equipment is installed in paper mill power plants to operate at a sufficiently high pressure to eliminate the necessity for condensers or another source of power. The increment cost for additional boiler plant capacity to supply steam for condensing, in order to generate power above process steam demands, is relatively small due to the low steam rates required for this operation. If turbines for generating by-product power are to be installed, the additional cost to make the turbines themselves suitable for condensing would also be small. The cost of operation of condensing equipment for paper mills located near waterways would be less than at other locations where it would be necessary to install spray ponds or cooling towers and purchase make-up water. In some paper mills, such as box board plants, the water for the beaters is discharged through the power plant condensers. This water is heated to approximately 150 deg. F. by operating the turbines at a back pressure of approximately 8 lb. absolute with the result that the heat ordinarily lost in condensing water is saved and utilized for process. The

advisability of installing condensing equipment should be decided on a comparison of power costs between condensing, Diesel engines and public utility rates as determined by local conditions.

Diesel Engines

Diesel engines are simple, rugged and highly efficient units, which maintain their performance during many years of operation under a reasonable maintenance schedule without material sacrifice of thermal efficiency at reduced loads.

The field of application for Diesel engines in the power industry is probably limited to mills where power is required in excess of that generated by present water-wheels already installed and power generated as a by-product of process steam. The decision to obtain power from condensing steam, Diesel engines or a public utility should be based on actual local conditions pertaining to the cost of operation and investment.

Public Utilities

Where power is purchased from an outside source to operate in parallel with equipment in a paper mill power plant, a relay system should be installed to prevent overloading the generators in the mill plant, in case of failure of the purchased power system. This can be done by tripping out momentarily nonessential mill equipment such as chippers, beaters, jordans, or any other equipment that has reserve process storage capacity.

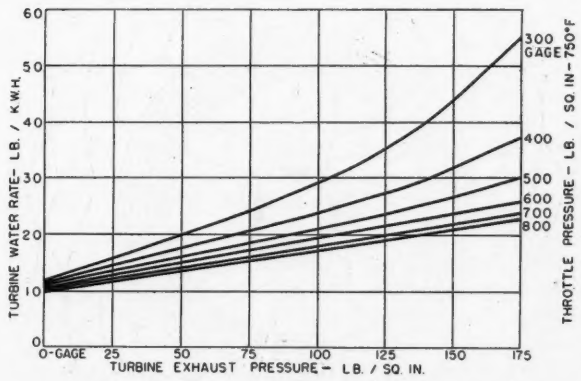


Fig. 2. Theoretical Turbine Steam Rates Based on Various Throttle and Exhaust Conditions at 100 per cent Rankine Cycle Efficiency

The use of purchased power should be given consideration, particularly where parallel operation is available. Energy demand, minimum charges and the duration of the contract submitted must be carefully studied and compared to the cost of generating power at the mill by condensing or Diesel engines.

There are paper mills that obtain water power from their own development and also generate power as a by-product of process steam that at times have a surplus of available water power. In certain types of paper mills, the steam requirements are more than sufficient to generate all power required in the mill as a by-product. These mills, in some instances, have made arrangements with a public utility for the sale of all power not required in the mill to the advantage of all concerned.

Fig. 3. Pipe line supplying 100,000 lb. steam at 25 lb. gage from central power plant to a paper mill

In the East, where the manufacture of paper is an old, established industry, many paper mills were located to take advantage of water power with the result that today each mill of a group may be isolated and supplied by its own steam and power plant. Replacement of these plants by one central power plant would effect considerable savings by consolidating steam and power generation to larger and more efficient equipment; by added flexibility of steam and power distribution; and by confining all supervision to one operating force. The photographs accompanying this article show turbines in a modern paper mill power plant with exhaust steam line from the power plant to a group of mills spread along a river for a distance of more than a mile. This central steam and power plant replaced five isolated plants. All steam is now generated in the central plant by high-pressure boilers and expanded through the turbines, whence it is carried at 25 lb. pressure by pipe lines to the various mills. Power is obtained as a by-product of the steam required for process and is distributed to the mills by underground cables.

Similar to many other industries in this country, the paper industry has been expanded to a point where competition is very keen. Power and steam costs constitute a large portion of the cost of manufacturing paper and any saving effected by these items is naturally reflected in the cost of paper and the profit or loss of the mill. Many paper mills, realizing this condition, have investigated the possibilities of modernizing their power plants and consequently have installed modern equipment with the result that large savings in the cost of steam and power have more than justified the expenditure. However, there are many paper mill power plants that are obsolete both as to the generation and distribution of steam and power and any expenditure made in the future should form the basis for an ultimately modern and efficient plant, as determined by a complete study of conditions applicable to the particular mill.

Here is an article explaining the possible changes that can be made in D. C. Armature windings to change the voltage, speed or power, by merely reconnecting the coil leads at the commutator, without otherwise disturbing the winding of the armature. When changes are made in the windings it is often necessary to make changes in the brushes. Also when the speed or horsepower is increased the armature must be thoroughly investigated to make sure it will stand the mechanical strains.

Reconnecting D. C. Armatures For Different Conditions

By E. F. DOWIS

IT IS OFTEN DESIRABLE to operate a motor or generator at a speed, or voltage, different from that for which it is wound. It is the purpose of this article to show the possible changes which can be made in an armature winding by reconnecting the coil leads at the commutator, without otherwise disturbing the winding. These changes are practical in armatures where the leads from the coils are available without disturbing the coils, and in many cases only the top leads need be changed.

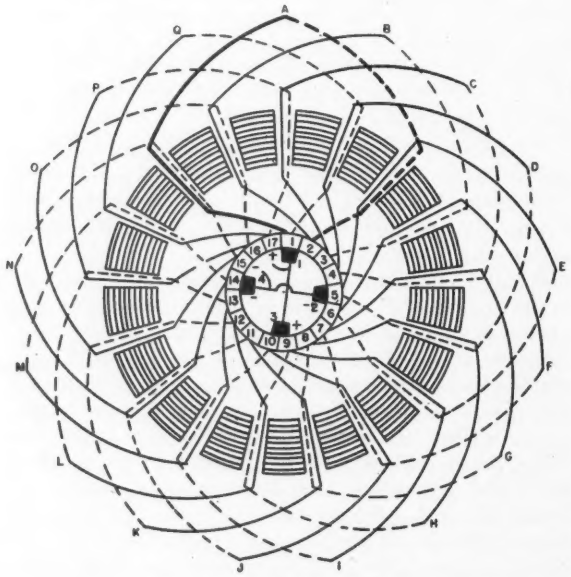


Fig. 1. Simplex lap winding

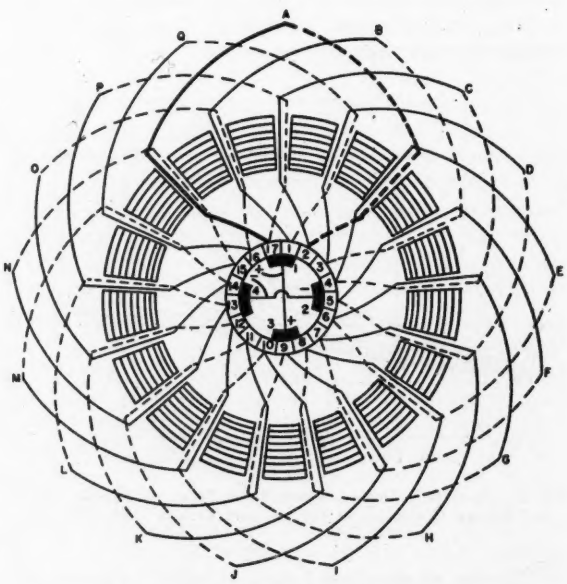


Fig. 2. Duplex lap winding

The usual procedure in winding armatures (excepting those of very small size) is to wind the coils separately and, as they are placed in the slots, connect the bottom leads to the commutator. This leaves the top connections out until the coils are all in place, and they are readily available after the winding has been completed.

To demonstrate the possibilities, let us assume an armature having 17 slots and 17 commutator bars, wound for four field poles. With this simple arma-

ture as a basis, we can demonstrate the possible changes, in connection, which can be made, and how they will affect its operating characteristics.

To determine how an armature is wound, it is only necessary to lift the top leads from the commutator bars, and, using a test lamp or any similar device, determine to which two bars any one coil is connected. If it connects to adjacent bars, as in Fig. 1 (see coil A) it is a simplex lap winding. If it connects two bars apart as in Fig. 2, it is duplex lap; if three bars apart triplex lap, etc. Incidentally, all armatures wound for only two field poles are lap wound. If, on the other hand, there are a larger number of bars between the start and finish of a coil, as in Fig. 3, it is a wave winding.

Now, other conditions remaining the same, the voltage of an armature will vary directly as the num-

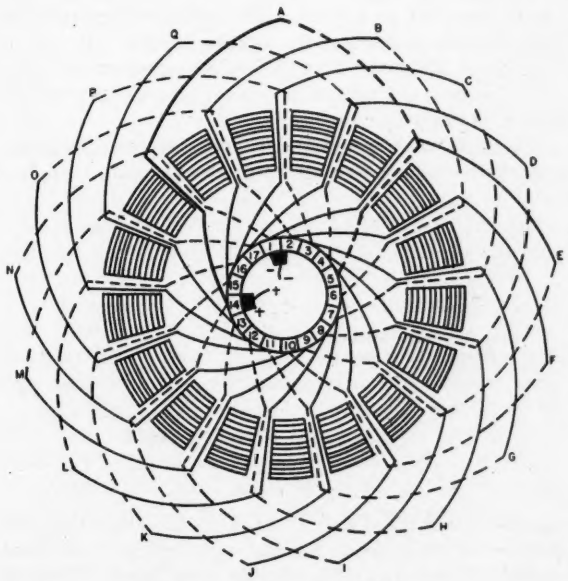


Fig. 3. Simplex wave winding

bers of coils in series between the positive and negative brushes of the machine. The current capacity in amperes will vary as the number of parallel circuits through the armature. If the voltage is to remain the same, the speed and rated horse power can be changed, and will vary inversely with the number of coils in series.

Lap wound armatures require at least as many brushes as there are field poles. They are shown, with their relative polarity, in the drawings. You will see in Fig. 1 that by tracing from brush 1, through bar 1, and coil A, current must travel through four coils in series to reach brush 2. Also you will note that there are four paths, or circuits, through this armature by which current may pass from the positive to the negative line, two from each positive brush.

Now to consider the possible changes which we can make in these connections, and how they will affect the voltage, speed, and power of the machine. Suppose we lift the top leads of the coils from the commutator. (The top connections and top sides of the coils are shown as solid lines, and the lower as

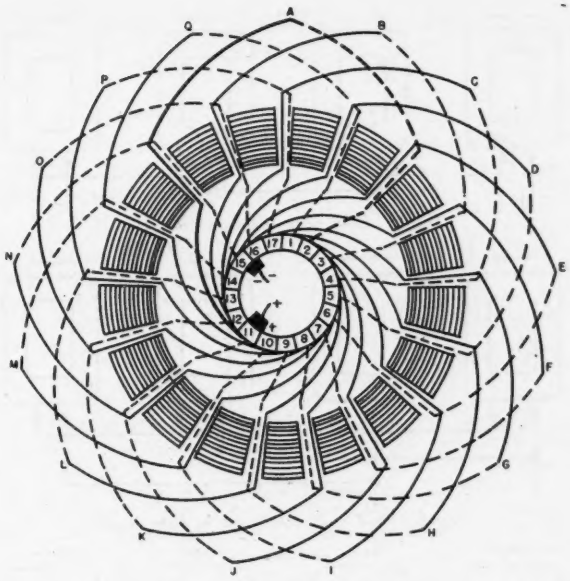


Fig. 4. Simplex wave winding

dotted lines.) Now, if we move them back one bar, without disturbing the coils, or the lower connections, we have the winding illustrated in Fig. 2. It will be necessary for our brushes, with this kind of winding, to cover at least two commutator bars. It can be seen that instead of four coils in series between a positive and negative brush, we now have only two, and instead of four circuits between the machine terminals, we have four from each positive brush, or a total of eight circuits through the armature. The results of this simple change have been:

In a Motor

If operated at the same voltage, the speed will be twice as fast, the torque remaining the same, giving double the horsepower rating. If operated at ½ the original voltage, the speed and power will remain constant, but will draw twice as many amperes.

In a Generator

If operated at the same speed the voltage will be reduced ½, but the current capacity, in amperes, doubled, making the kilowatt rating the same. If the speed is doubled, the voltage will remain the same and current capacity and kw. rating doubled.

It is sometimes possible, with larger armatures, to move the leads three or four bars away, and proportionately increase the brush thickness, in which case the voltage will be reduced to ⅓ or ¼ of the original for the same operating conditions. These same relative changes apply to any lap winding regardless of the number of coils, slots, or commutator bars.

It is necessary to remember that any increase in speed will be accompanied by increased mechanical strains on the armature. Before attempting any increase in speed it is very important to study the mechanical construction of the armature, in order that it may not be wrecked by the increased speed. Attention should also be paid to the mounting of the machine, and bearing construction before greatly increasing the speed.

A simplex lap winding has the highest voltage

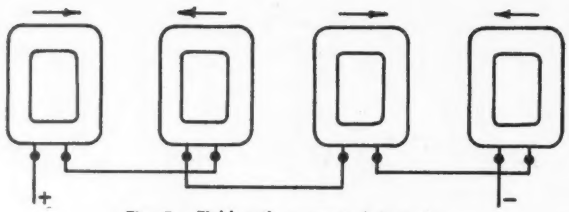


Fig. 5. Field coils connected in series

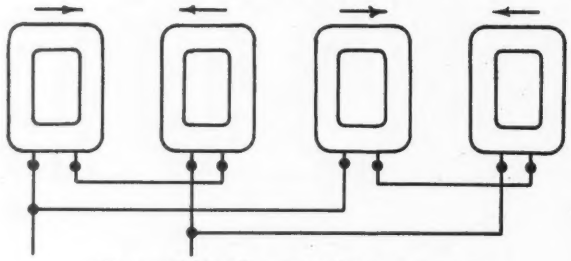


Fig. 6. Field coils connected in two circuits

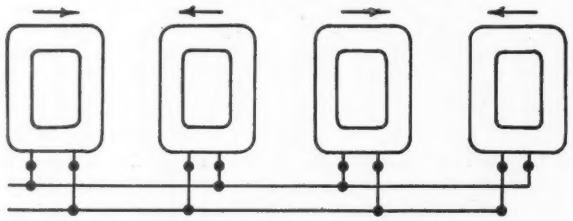


Fig. 7. Field coils connected in three circuits

which it is possible to secure with a given lap winding. It is sometimes possible to change a lap, to a wave winding, and thereby increase the voltage, or decrease the speed. All armatures cannot be wound simplex wave, for any particular number of field poles. To determine this we subtract or add 1, to the number of commutator bars, and divide by ½ the number of main field poles. In the case of the armature we are considering

$$17 - 1 = 16 \div 2 = 8$$

If this last number had not been a simple number, without a fraction, the armature would not wind simplex wave, for instance; if we had an armature with 16 bars, and four field poles we would have,

$$16 - 1 = 15 \div 2 = 7\tfrac{1}{2}$$

or

$$16 + 1 = 17 \div 2 = 8\tfrac{1}{2}$$

consequently, an armature with 16 commutator bars cannot be wound simplex wave for four poles, as neither 7½, nor 8½, is a simple number.

Now let us see how to reconnect our winding from a lap, to a wave winding, and how it will affect our operating charactertistics.

$$17 \text{ bars} - 1 = 16 \div 2 = 8$$
$$17 \text{ bars} + 1 = 18 \div 2 = 9$$

Fig. 8. (A) Brush for duplex winding (B) Brush for triplex winding

This means that we can connect the top and bottom leads of our coils either 8, or 9 bars apart, and in order to keep the leads as short as possible, usually the smaller number is chosen. If it is possible to get at the bottom leads, we move them around far enough, so that the leads will not be longer than before, as in Fig. 3. If the bottom leads cannot be reached without damaging the winding the top connections may be lengthened, by splicing, and connecting as shown in Fig. 4. There may be some difficulty in keeping leads of such length in order, and they must be well bound so as not to be thrown out by centrifugal force. In either case, with the bottom leads connected in order, we can start with any coil, and connect its top lead as far back from its bottom lead as the number obtained from our formula, which, in this instance, is 8. If the bottom lead from coil A is connected to bar 5, as in Fig. 3, counting 8 bars back, we find the top lead should connect to bar 14. The rest of the top leads can then be connected in regular order. If, as in Fig. 4, we leave the bottom leads as they were, with coil A connected to bar 2, we must connect the top lead 8 bar away, or to bar 11.

Now, a wave winding requires only two brushes, spaced the same angular distance as a pair of poles,

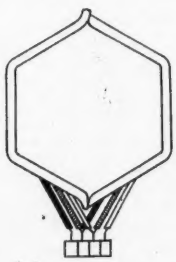


Fig. 9. Three element coil connected simplex lap

as shown in Figs. 3 and 4. If more are used, they are connected the same as for lap windings, and are used to reduce the current density in each brush. Tracing our circuits in Figs. 3 and 4, we find that we have only two circuits from the + to the — brush, and that current will flow through eight coils in series from brush 1, to brush 2, as can be seen by tracing the circuits, starting at the top lead of coil A, and the bottom lead to coil J. There may be a difference of one coil, in the number in series, due to the fact that one of the brushes rests partly on two commutator bars. This, however, will not affect our results on the actual armature, as this coil will be in a neutral position in the magnetic field when the brush rests on two bars.

In changing from a lap, to a wave winding, therefore, the voltage is increased by as many times as there are pairs of main field poles. For a 4-pole machine, the voltage will be doubled, for a 6-pole machine it will be tripled, etc. Any wave winding may be changed to a lap winding, with a reduction in voltage in the same proportion. The number of brushes must also be increased, if there are less than the number of main field poles.

Double and triple wave windings are seldom used, as better results are more easily obtained by changing to a lap winding. Smaller armatures wound simplex wave will not usually wind duplex wave for the same

number of poles. To determine this we use the same formula for finding the commutator pitch, as for simplex wave, but use the number 2, for double, or 3 for triple intsead of 1, as in single wave.

If an armature is changed from wave to lap, the voltage remaining the same, the speed will be increased by as many times as there are pairs of main field poles, or, if changed from lap to wave, the speed will be reduced in the same proportion.

It must be remembered, of course, that if the voltage of a machine is changed, the field coils will have to be reconnected, or rewound for the different voltage. If, as is usual, the coils are connected in series, as in Fig. 5, and the voltage is to be reduced to ½, we can reconnect them as in Fig. 6, into two circuits, being careful not to change the relative direction of current in the coils, when making the change. If the voltage is to be reduced to ¼ the original, they could be connected as in Fig. 7.

If it is not possible to connect the coils for the required voltage, they can be rewound, using an increase, or decrease in the number of turns, in the same ratio as the voltage change, and decreasing or increasing the wire size in inverse proportion to the number of turns. It is well to state here, that, to determine the wire size to accomplish this, we take three numbers higher, on the B S Gauge to get a wire ½ as large, or three numbers lower to get one twice as large.

It is also necessary to have the brushes span at least two commutator bars to operate with a duplex winding, and three, to operate a triplex winding. This can sometimes be accomplished by cutting new brushes in some such shape as those in Fig. 8, to fit the original brush holders, or the brush holders can usually be changed to accommodate larger brushes. Many machines have brushes spanning the required number of bars, and do not have to be changed.

Some armatures have two, or three times as many commutator bars, as slots and coils, and in these armatures each coil is really two, or three coils wound together as shown in Fig. 9. When made up, these coils are identified, usually with colored sleeving, the start and finish of one coil being marked in the same way. A complete three element coil, connected simplex, lap, is shown in the figure. By lifting the top leads out, and moving them one bar to the left we could make this a duplex lap winding, the same as a single element winding. In other words, we treat each element in the multiple coil as an individual coil.

The above instructions apply to all armatures with formed coils laid in the slots, and connected to the commutator in the manner explained, which is the method used in most of the armatures of larger machines. For smaller armatures, where the wire is wound directly into the slots it is usually better to rewind the armature for the desired voltage, using the method explained for rewinding field coils, in a preceding paragraph. Any armature, which cannot be reconnected for the desired speed, or voltage may be rewound by this method, varying the number of turn directly with the change in voltage, and inversely with the change in speed, and varying the area of the wire used inversely to the number of turns.

Quindaro's 30,000 Kw. Addition

(Continued from page 429)

generator neutral current transformers are installed in the busway using 6-conductor busway to the neutral point and 4-conductor busway from that point to the main buses.

CONTRACTS FOR CONSTRUCTION AND EQUIPMENT

1. Steam Generator 150,000 Lb./Hr.—Babcock & Wilcox	$ 249,908.00
2. Turbine Generator 37,500 kv-a.—Westinghouse Elec & Mfg.	554,485.17
3. Condenser, 40,000 sq. ft.—Westinghouse Elec. & Mfg.	119,541.00
4. Switchgear—Westinghouse Elec. & Mfg.	350,375.50
5. Station Transformers—Westinghouse Elec. & Mfg.	14,785.44
6. Excavation and Piling—E. A. Whitney & Sons, Inc., and Jones-Hettelsater Const. Co.	41,926.41
7. Ash Sluicing Equipment—Allen Sherman Hoff Company	12,060.12
8. Circulating Water Valves—Ludlow Valve Mfg. Company	23,563.00
9. Cast Iron Pipe, 60 in., 42 in. and 36 in.—U. S. Pipe & Foundry Co.	12,290.48
10. Steel Pipe, 60 in., 42 in. and 36 in.—The Darby Corporation	9,500.00
11. Building and Misc. Structures—S. Patti Const. Co., Inc.	487,843.28
12. Closed Heater and Evaporator—Foster Wheeler Corp.	18,202.00
13. Deaerating Feedwater Heater—Cochrane Corporation	12,951.00
14. Boiler Feed Pumps—DeLaval Steam Turbine Co.	12,704.00
15. Power Piping—Interstate Heating & Plumbing Co.	188,758.37
16. Power Wiring—W. T. Foley Electric Co.	105,667.54
17. Linoleum—K. C. Natural Slate Co.	1,344.00
18. Public Address System—Graybar Electric Co.	7,762.05
Total	$2,223,667.36
Force Account Work by Department	29,967.76
Total Cost 1937 Addition 30,000 K.W.	$2,253,635.12
Total Cost 1931 Addition 10,000 K.W.	1,243,446.22
Total Cost 1933 Addition Boiler	297,611.93
TOTAL COST TO 1938, 40,000 K.W. CAPACITY	$3,794,693.27

Total costs to the present time are approximately $3,800,000 with installed generating capacity of 40,000 K.W. However, in considering a cost per K.W. of installed capacity it must be kept in mind that the control and switchgear are included for 29,000 K.W. of old equipment in five units, space is provided for an additional boiler, and part of the space and foundation piling for the next generating unit and coal handling facilities are for the ultimate plant size. Costs now per K.W. of generating capacity are about $95 per K.W.

All engineering work and studies involved in the development of the plan of procedure and for ultimate capacity, together with the detailed plans, specifications, and supervision of construction have been in charge of the Burns & McDonnell Engineering Company of Kansas City, Missouri.

Part III*. Piping; Materials and Working Stresses in Pipe and Valves; Inspection; Layout; Fabrication; Anchors, Hangers and Sway Bracing. Throughout the history of steam-power plant development advancements in the art have been possible as a result of collateral developments in practically all branches of design and manufacture of power plant equipment. Among these improvements probably none is more spectacular than the progress made in the field of piping. Developments in metallurgy, manufacturing processes, and welding technique all have been combined to produce piping systems that, compared with older designs, are safer to use, less expensive to build, and simpler to operate. It is little wonder, then, that rather striking contrasts exist between piping systems in the first section of Delray PH 3 and those in the extension built ten years later. An account of these piping developments follows.

High-Pressure Extension of Detroit Edison's DELRAY PLANT

By
MAX W. BENJAMIN
Engineering Division,
The Detroit Edison Co.

THE STEADY rise of steam pressures and temperatures used in power plants has imposed increasingly severe operating conditions upon piping systems, particularly those carrying the main superheated steam and boiler feedwater. For many years the increasing burden was accommodated merely by increasing the wall thickness of the carbon steel pipe. Although the heavier walls stiffened the pipe structure it was possible to design for adequate flexibility on a rational basis derived from the results of experimental and analytical investigations of the flexibility problem. Thus, carbon steel was satisfactory for steam piping until steam temperatures exceeding 750 F came into use, but with the advent of temperatures of 825 F to 850 F at Conners Creek serious thought was given to the selection of a proper piping material. After making a number of short time tensile and creep tests on Grade A and Grade B carbon steel pipe conforming to ASTM Spec. A106 it was concluded that a silicon-killed, medium-carbon steel would be suitable for use at temperatures up to 850 F permitting operation at a girth stress up to 7400 psi.

*Part I of this series of five articles was published in the March issue and Part II in May, others will follow.

Fig. 37. West header gallery in condenser room, showing headers for general-service water, building-heating steam, compressed air, lubricating oil, and miscellaneous other services

Delray Superheated Steam Piping

In the Delray extension normal steam pressure and temperature of 865 psi g and 910 F are expected at the superheater outlet, and temperature swings up to 925 F must be expected and provided for. The maximum steam pressure with all safety valves blowing will be 1007 psi g but this condition is of little significance since it will seldom occur and then for but a few minutes at a time. Under these circumstances the factor of safety in the material is deemed to afford sufficient reserve strength without attempting to design for a working pressure above 865 psi g. The last few tubes in the superheater, which carry the hottest steam and are surrounded by the hottest gas, operate at metal temperatures considerably above 925 F. They are made of alloy steel containing from 4 to 6 per cent chromium

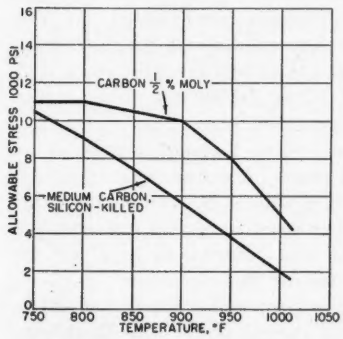


Fig. 38. Allowable stress in killed-carbon and in carbon-molybdenum steel pipe at elevated temperatures

and 0.5 per cent molybdenum. A lower alloy is suitable for the steam piping, however, since it is out of contact with the combustion gases and will operate at temperatures no higher than that of the steam, that is, not over 925 F. As shown on Fig. 38 the allowable working stress for killed carbon steel drops from 7400 psi at 850 F to only 4700 psi at 925 F. Piping designed for this reduced stress would be doubly expensive because the increase in wall thickness not only would add to the weight of material used but also would make the pipe so stiff as to require special provisions to accommodate thermal expansion. Fortunately a ½ per cent molybdenum alloy steel is capable of withstanding stresses up to 9000 psi at 925 F with a creep rate well inside one per cent in 100,000 hr which permits, in accordance with the theory followed, a thinner wall than could be used in killed-carbon steel at the same pressure and only 850 F. While the price per lb of this alloy steel at present is about double that of killed-carbon steel, the overall cost of the steam piping for 925 F is estimated to be lower, by virtue of reduced weight.

For determining the necessary pipe-wall thickness a working stress of 8250 psi was used in the formula specified in the Code for Pressure Piping. This stress is considerably lower than the present limit established by the Boiler Code but is somewhat higher than the stress limit of 7700 psi approved by the Boiler Code at the time the decision was made. Use of 8250 psi in design was based upon the results of some short time creep tests run at the University of Michigan, and observations by The Detroit Edison Company of some thin walled carbon-moly pipe sections in an experimental superheated steam line at Trenton Channel. At a temperature of 900 F and stress of 9220 psi, the specimens at Trenton Channel exhibited a creep rate of about 1½ per cent in 100,000 hr. Both of these sources of information pointed to the use of an allowable stress approximating 8250 psi, and, with the knowledge that the Boiler Code stress was believed to be too low, it was decided to use this value in the pipe-wall thickness formula. The decision appeared to be somewhat radical at the time, but, by comparison with the later Boiler Code value of 9000 psi, it now appears to have been conservative. On the other hand, it is possible that the Code stress of 9000 may again be revised downward. The 8250 lb stress seems to have been a fortunate choice.

The pipe wall thickness calculated with a stress of 8250 psi requires the use of Schedule 100 pipe in sizes 8 in. and larger. Because Schedule 100 has no sizes under 8 in., Schedule 120 is necessary in 4 and 6 in. sizes and Schedule 160 in sizes 2½ in. and smaller. These selections also conform with those agreed upon in 1936 by the pipe manufacturers and the Prime Movers Committee of the Edison Electric Institute for the purpose of stocking carbon-moly pipe for steam conditions up to 900 psi g at 900 F.

The actual working stress corresponding to the selections stated above is, of course, something less than the 8250 psi assumed in calculating the thickness. This depends upon the difference between the nominal thickness of the standard schedule and the required thickness calculated by the formula, the variations from standard permitted by the allowed tolerance, the amount of corrosion allowance and so on. Based on the nominal thickness, and assuming no corrosion, the stress in an 8-in. pipe at 1007 psi g for example would be 8220 psi and at the normal working pressure of 865 psi g would be but 7060 psi. On the other hand, the stress caused by a pressure of 865 psi g in an 8-in. pipe having the minimum allowable wall thickness and deducting the corrosion allowance would be 8220 psi.

It is interesting to note the widespread agreement among engineers on the use of carbon-moly pipe for steam temperatures of 900 to 950 F. A whole series of recent stations designed or operating at pressures from 775 psi g at Columbia to 2500 psi g at Twin Branch all use the same piping material.

The modern practice of welding valves into the pipe line requires the use of steel having good welding properties and at the same time having soundness of structure and high temperature physical properties approaching those of the wrought pipe material. Cast valve bodies have always been made heavy because the bonnet opening produces an inherently weak shape as compared with a cylinder, but the need for tapering down the valve ends for strength welding to the adjoining pipe, requires the use of alloy steel of superior properties, including resistance to shock. To obtain these properties in a cast metal required both technical advances in metallurgy and practical changes in foundry practice.

Carbon-molybdenum cast steel is considered by engineers and metallurgists to be entirely satisfactory for welding-end valve bodies in steam services up to 900 psi g at 950 F. However, the nickel-chromium-

molybdenum alloy now known as alloy C4 in ASTM specification A157 was used in the 850 F steam valves at Conners Creek with such good results that it was adopted for use at 925 F in the Delray extension. Alloy C4 has the chemical composition and physical properties shown in Table XI under the section on "Inspection of Valves and Pipe." As compared with carbon-moly cast steel the presence of chromium and nickel in addition to molybdenum produces a material having not only superior physical properties at room temperature but also somewhat greater creep resistance at elevated temperatures.

Throughout the Delray plant piping there is an almost universal use of stainless steel or iron for valve stems and of No. 6 Stellite for seat and disc facing. These, along with other valve trim items will be summarized later on in Table X.

While the choice of a proper dimensional standard for superheated steam valves does not now appear to have been a particularly difficult task, a number of factors were considered by the engineers responsible for the valve selections. The following paragraphs, quoted from the design notes on the subject of valve selection, show how the decisions on valves were reached.

Pressure Standard for Steam Valves

"The pressure and temperature ratings given in the present American Standards for Steel Flanged Fittings and Companion Flanges, ASA B16e, 1932, are for carbon steel. Since it is common practice to employ alloy castings of one kind or another for valve-body castings, tables or ratings for carbon-moly or equivalent alloy are now under consideration. Two distinct tables of ratings have been circulated to members of ASA Subcommittee B16e.* The table for valves having raised-face flanges rates the American Standard for 900 lb SSP as good for 900 lb at 900 F if made of carbon-moly or equivalent alloy material. A second table based on the use of ring type end flanges proposes to rate the present 900 lb standard as good for 900 lb at 950 F when made of alloy material.

"On this same basis even a higher rating might reasonably be assigned to welding-end valves as the problem of keeping bonnet joints tight is not complicated by bending moments as is true in the case of end flanges.

"The metal thickness of the 900 lb standard is adequate for the higher temperature rating proposed for carbon-moly. For example; the stress in the cylindrical portion of a 10-in. valve body based on the minimum metal thickness is only about 4300 psi by the straight Barlow formula for a pressure of 900 psi. Even if this stress were increased by 50 per cent, as is customary, to compensate for the bonnet opening, it would be less than 6500 psi.

"The bursting stress in the reduced section of a welding-end valve turned down to 1/16 in. greater than the nominal wall thickness of Schedule 100 pipe is approximately 6300 psi for an internal pressure of 900 psi. There would be no advantage in using a heavier valve standard since the welding end would be the same thickness in any case.

"While raised face flanges of the 900 lb std apparently are considered by the American Standards Committee B16e as satisfactory for 900 lb at 900 F, there is considerable reason to question whether a gasketed joint could be maintained tight under this pressure and temperature condition if there were an appreciable bending moment acting at the joint.

"Computations based on rather arbitrary assumptions of points of application of bolt loads and gasket reactions, show that a bending moment corresponding to a total stress (longitudinal pressure stress plus bending stress) of 9000 psi in the pipe adjacent to a 12-in. joint probably would cause a 900-lb flanged joint to leak if used on 865-lb pressure and 910-F service.

"Exactly similar calculations for a 1500-lb. flanged joint show that it could be expected to maintain a tight joint indefinitely on 865 lb, 910 F service with a bending moment corresponding to a total stress of 10,000 psi. These calculations were based on the assumption that carbon-moly or alloy C4 flanges would support a stress of 8000 psi at 910 F while alloy B13 bolting material would carry 10,000 psi after stress adjustment with time had taken place.

"Where there is no bending moment acting, as in the case of valve bonnet joints, or connections to safety valves, the 900 lb standard should prove adequate for 865 lb, 910 F service. The residual gasket compression on a gasket 3/8 in. wide was determined as about 10 times the internal pressure for this condition.

"On the basis of the proposed ratings for alloy flanged valves, a check of the minimum wall thickness, and calculations of the effect of bending moments, the following standards were selected for 865 psi, 910 F service.

(1) Welding-end valves, American Standard 900 lb SSP.
(2) Flanged-end valves, American Standard 1500 lb SSP.
(3) Superheater safety valves, American Standard 1500 lb SSP.

"For 910 F service a metal gasket appears essential. It is proposed to use a modified Sargol joint with a ground face for the superheater safety-valve connections and for all other flanged-end valves."*

Boiler-feed Piping

Essential considerations involved in the selection of pipe and valves for the high-pressure boiler-feed system are outlined in the following paragraphs which are quoted, some directly and some in modified and amplified form, from the original design notes on this subject.

There are two pressure and temperature conditions which require study with reference to their importance in regular operation, and two others that should be investigated as possible maximum conditions which might arise in cases of extreme emergency but would persist for no more than a few minutes all told in the entire life of the plant. These four conditions at the pump discharge are as follows:

*Note: These adjusted service ratings have since been incorporated in American Standard Steel Pipe Flanges and Flanged Fittings, ASA-B16e-1939.

*Actually the superheater safety valve connections are fitted with hydrogen-annealed soft iron gaskets while the throttle valve connections to the boiler-feed-pump turbines and to the superposed turbine are fitted with "profile solid serrated monel" gaskets.

	Pressure	Temperature
Normal continuous maximum boiler rating	1092 psi	260 F leaving pump at maximum turbine load
Extreme maximum boiler rating, with all safety valves blowing	1186 psi	388 F leaving last feedwater heater
Pump shut-off pressure at speed corresponding to extreme boiler rating and normal drum pressure	1325 psi	
Pump shut-off pressure at maximum pump speed	1445 psi	

From this variety of pressure conditions at the upper end of the operating range it obviously is necessary to select one as a nominal basis for design of the feed piping. The first to be questioned is, of course, the full speed shut-off pressure of 1445 psi g, and the weight to be given to it depends upon the type of pump drive. If the pump were to be driven at constant speed, the shut-off pressure would be approached whenever the main unit operated at light load because the pressure-flow characteristic of most all modern feed pumps is rather flat from shut-off out to half load or beyond. Furthermore, such a pump would be designed to operate always at sufficient pressure to feed the boiler against maximum drum pressure with all safety valves blowing, i.e., 1186 psi g. Some further discussion of this point will appear in a later installment. It is the practice of The Detroit Edison Company to use an adjustable-speed drive on boiler-feed pumps, however, and to operate the pump at a speed commensurate with the duty imposed upon it. Therefore, under all normal conditions the pump discharge pressure needs to be only 1092 psi g or less, and the pump is operated at a reduced speed which matches the requirements at the moment. Only in an extreme emergency involving the coincidence of several difficulties will the full speed shut-off pressure be attained and in that case will amount to nothing more than hydrostatic test at that pressure. Piping and valves should withstand such a pressure without bursting and without permanent distortion, but beyond this, the 1445 psi g pressure is not considered to have any significance. The occurrence of shut-off pressure at any other speed is subject to the same analysis as at full speed. It is extremely doubtful that there is any more likelihood for shut off to occur at reduced speed than at full speed, and the condition may be discounted safely because of its improbability. The safety factor in the pipe material will provide more than enough reserve strength to accommodate these conditions as well as shock due to water hammer.

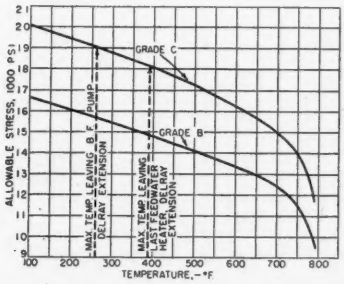


Fig. 39. Allowable stress in ASTM Specification A 106, Seamless Carbon-Steel Pipe

On the other hand, the necessity for feeding the boiler when the safety valves are blowing is a very real one, and, although a somewhat remote combination of circumstances is required to blow the valves at the extreme boiler rating, it is a condition which must be met. With adjustable speed pumps this probably is the logical basis for the pipe and valve selection. Since all other conditions, such as the normal pressure at normal maximum boiler rating, are less severe, they need not be considered. It should be noted here that while adjustable-speed drive for boiler feed pumps in Detroit Edison plants is predicated on other factors, this type of drive, it is believed, justifies the use of relatively lighter weight feedwater piping than probably would have been selected for service with constant speed pumps.

With a design basis established, the selection of proper materials and dimensional standards for piping and valves became possible. Quoting again from the design notes:

"The superior grade of medium-carbon-steel pipe obtained for Conners Creek at no cost premium suggests its use for boiler-feed piping at Delray PH 3. This special-analysis silicon-killed medium-carbon steel possesses room-temperature physical properties approaching that of Grade C pipe of ASTM Spec. A106, although specified to conform to Grade B requirements.

"The allowable stresses for Grade B and Grade C pipe as given in the power piping section of the Code for Pressure Piping for different working temperatures are plotted in Fig. 39.

"Schedule 80 pipe, if made of material conforming to Grade B requirements, is entirely adequate for the boiler-feed pressure and temperature conditions. The hoop stress in 8-in. Schedule 80 pipe at maximum boiler rating is 12,660 psi as computed by the Code for Pressure Piping formula. The stress based on minimum wall thickness permitted on inspection is only 10,800 psi for this condition. The allowable stress for Grade B pipe for a temperature of 388 F which is the maximum temperature leaving the last stage heater, is approximately 15,000 psi. For the temperature of 260 F at the discharge of the boiler-feed pump the allowable stress is about 15,500 psi.

"The girth stress in the pipe by Code for Pressure Piping formula for the condition of maximum evaporation with allowance for 6 per cent drum over pressure is 13,720 psi. Under shut-off pressure, maximum boiler rating, and normal drum pressure, the girth stress might rise to 15,400 psi by Code formula or an actual stress of approximately 13,100 psi.

Pressure Standard for Feed Valves

"On the basis of the pressure-temperature ratings for carbon-steel flanged fittings and companion flanges of ASA B16e as amended in 1935, the 900 lb std is adequate for boiler-feed service at Delray PH 3. These ratings for the temperature range involved in the boiler-feed system are tabulated below:

Service temperature F	Allowable service-pressure for 900-lb std, psi
250	1350
300	1305
350	1260
400	1215

TABLE IX. SELECTION OF MATERIALS AND DIMENSIONAL STANDARDS FOR PIPING IN DELRAY EXTENSION

	Pipe, Schedule and Specification Number	Style of Joint Nominal Sizes Used, Inches			Flanges and Fittings, Material and Pressure Standard			Valves, Material and Pressure Standard		
		Screwed	Flanged	Welded	Screwed	Flanged	Welding	Screwed	Flanged	Welding
Air, compressed	40-A120	3—[1]	4+	2½+B	Mall iron 150	Cast iron[5] 125	Steel Sched 40[3]; 150	Brass 125	Cast iron 125	
Blowoff, Boiler to last valve	80-A106		1+	2—S[2]		Steel 150	Steel 3,000[4]; 1,500[5]		Steel 1,500	
Beyond last valve	40-A106		2½+	2—S 2½+B		Steel 600	Steel; 3,000 Sched 80; 600		Steel[11] 600	
Evaporator	40-A135	2 and 3	4+	2½+B	Cast iron 125	Cast iron[6] 125	Steel Sched 40; 150	Brass 125	Cast iron 125	
Condensate, 200 lb	40-A106[3]	½ to 2	2½+	2—S 2½+B	Steel 3,000	Cast iron 250	Steel; 3,000, Sched 40; 300	Steel 300	Cast iron 250	
100 lb	40-A106[3]	½ to 2	2½+	2—S 2½+B	Cast iron 125	Cast iron 125	Steel; 3,000, Sched 40; 150	Brass 125	Cast iron 125	
Drain, equipment	40-A120[9] galvanized	3— (soldered)	4+		Cast iron, 125 Mall iron, 150	Cast iron[6] 125	Steel Sched 40; 150	Brass 125	Cast iron 125	
Drip, Superheated	160-A206		2½+	2—S 2½+B			Steel 3,000; 1,500		Alloy Steel[10] 1,500	Alloy Steel[10] 1,500
900 lb saturated	80-A106		2½+	2—S 2½+B		Steel 1,500	Steel; 3,000 Sched 80; 1,500		Steel 1,500	Steel 1,500
200 lb saturated	Th-80 W-40	½ to 2	2½+	2—S 2½+B	Steel 3,000	Steel 600	Steel; 3,000, Sched 40; 600	Steel 600	Steel 600	Steel 600
Exhaust, Turbine bleeder	40-A106[3]		2½+	2½+B		Steel 600	Steel; 3,000 Sched 40; 600		Steel 600	Steel 600
Auxiliary turbine	⅜ wall A 135		12	12 B		Steel 150	Steel; Fabricated 25-lb plate			
Feedwater, Connections to boiler	100-A106		2½+	2½+B		Steel 1,500	Steel 1,500			Steel 1,500
System	80-A106		2½+	2—S 2½+B		Steel, 900	Steel; 3,000, Sched 80; 900			Steel 900
Instrument, High Pressure	80-A106 160-A206		¾+	2—S			Steel; 3,000, 1,500[7]	Steel[12] 3,000	Steel 1,500	
Low Pressure	40-A120[11]	3— (flared)	4+	2—S	Steel 3,000	Cast iron[6] 125	Steel; 3,000, 150	Brass 125		
Oil, Turbine lubricating	40-A106	2½—(solder seal)	¾—4	½—3S 2½& 3B		Steel 150	Steel; 3,000 Sched 40[13]; 150 and 400[7]	Brass 125		Steel 150
Transformer	40-A120	3—	4+	½—3S 2½ & 3B	Cast iron 125	Cast iron[6] 125	Steel 150	Brass 125	Cast iron 125	
Water, City and general service inside	40-A120[14]	3—	4+	2—S 2½+B	Mall iron 150, galv	Cast iron[6] 125	Steel; 3,000 Sched 40; 150[7,16]	Brass 125	Cast iron 125	Steel 150
City and general service outside	40-A120[15]	3—	4+—2+ B and S	2½+B	Mall iron 150, galv	Cast iron[6] 125	Steel; 3,000 Sched 40; 150	Brass 125	Cast iron 125	Steel 150
Steam, Main and auxiliary superheated	100-A206[17]		2½+	2—S 2½+B			Steel; 3,000[18] 1,500[7]		Alloy C4[19] 1,500	Alloy C4 900
900 lb saturated	80-A106		2½+	2—S 2½+B			Steel; 3,000 Sched 80; 1,500[7]		Steel 900	Steel 900
200 lb saturated	Th-80 W-40	1¼—	2½+	2—S 2½+B		Steel 300	Steel; 3,000 Sched 40; 300[7]	Steel 300	Steel 300	Steel 300
Vacuum	40-A135 A120	3—	4+	2½+B	Cast iron 125	Cast iron 125 Steel 150	Steel Sched 40	Brass 125	Cast iron, 125 Steel 150	Steel 150
Vent, Safety valve	40-A120 A135	3—	4+	2½+B	Cast iron 125; Steel 3,000	Cast iron[6] 125 Steel 150	Steel Sched 40; 1,500[7, 20]	Brass 125	Cast iron 125	Cast iron 125
Hotwell pump	Copper									

GASKETS.—Red rubber in joints up to 250 F, asbestos composition in joints up to 800 F, soft steel and monel for 925 F.

BOLTING.—Square-head machine bolts and hexagonal nuts with cast-iron flanges; bolt studs, Class A of ASTM Specification A96 for pressures up to 800 lb, temperature up to 750 F; Class C for pressures up to 1,200 lb, and temperatures up to 750 F. For temperature of 925 F, bolt studs Grade B13 of ASTM Specification A193 and Class 2H nuts of ASTM Specification A194.

[1] 3— is used to indicate sizes 3 in. and smaller, 4+ to indicate sizes 4 in. and larger. Th= threaded. W=welded.

[2] The letter S refers to socket-welded construction, B to butt welded; A120, A106, etc., to ASTM Specifications.

[3] Butt-welding fittings for use with Schedule 40 or Schedule 80 pipe.

[4] 3,000 refers to 3,000 lb forged-steel fittings for socket welding.

[5] 1,500, 600, 150, etc, in this column indicate standard of butt-welding flanges.

[6] Screwed cast-iron companion flanges may be used in these services.

[7] Lapped pipe and loose (Van Stone) flanges may be used in these services.

[8] Seamless A106 or resistance welded A135.

[9] Also A135, copper, Class L, extra-heavy cast-iron soil pipe and Class A cast-iron water pipe.

[10] Carbon molybdenum, Grade C1, ASTM A157.

[11] Copper tubing and thin-walled steel tubing with flared-tube connection or soldered copper.

[12] Screwed 3,000-lb steel valves remote from source.

[13] Connections to turbine 400 lb, remainder of flanges 150 lb.

[14] Sizes ½ to 3 in. galvanized, 4 to 10 in. black Schedule 40, 12 in. larger, ⅜-in. wall, welded joints require black pipe. Also copper pipe and counterbored fittings and valves for soldered joints.

[15] Also Class C cast-iron bell-and-spigot joints; lead (extra-strong quality) for city water; and copper Class K.

[16] Also plate slip-on flanges, 25 lb.

[17] Sizes ⅜ to 3 in., inclusive, are Schedule 160 carbon molybdenum, 4 and 6 in. Schedule 120.

[18] Grade F4 of ASTM A182.

[19] Grade C4 of ASTM A157.

[20] Vent from economizer relief valve; 1,500-lb flanges and valve.

"Under normal-maximum boiler rating the pressure at the boiler-feed pump discharge will not exceed 1092 psi. Even with allowance of 6 per cent over pressure at maximum evaporation the pressure will be less than 1186 psi. The shut-off pressure for maximum boiler rating and normal drum pressure is expected to be about 1325 psi, or slightly above the rated working pressure of the 900-lb. American Standard at the maximum operating temperature of 388 F leaving the last stage heater.

"These ratings are of necessity quite arbitrary but they do give an indication of past successful practice. There is no question of ability to secure and maintain adequate compression on the gasket surfaces with 900-lb American Standard flanges on boiler-feed service at Delray PH 3.

"Since welding-end valves have their ends turned down to 1/16 in. greater than the nominal wall thickness of adjoining pipe, there is no advantage as far as the strength of the welding-end is concerned in using valves heavier than the 900 lb American Standard.

"The terminating flanges on feedwater connections to the economizer are required by the Boiler Code to conform to the American 1500-lb Standard. The valves connecting to the economizers are likewise required to conform to the American Standard for 1500 lb. It would seem that the remaining valves and fittings in the boiler-feed system should conform to the American Standard for 900 lb."

As a double check on the above pipe selections the effect of different emergency conditions was investigated in terms of safety factor. For instance, the safety factor (referred to ultimate strength) at the normal pressure of 1092 psi g is about 4.7, based on the minimum wall thickness, and about 5.6 based on the minimum thickness permitted on inspection. For shut-off pressure at maximum pump speed the latter safety factor will be reduced to about 4, which still is ample. If the shock due to water hammer is included the safety factor is further reduced to about 3.

In connection with water hammer considerations it is of interest to note that the increase in pressure due to water hammer is relatively less important in high-pressure installations than in low-pressure systems. For various reasons including pressure loss, pumping power, and water hammer, it is customary to limit the velocity of flow in a water pipe to a maximum value of about 10 ft. per second irrespective of the pressure at which the line operates. Since both the water and pipe are relatively inelastic the shock due to water hammer is

TABLE X. SUMMARY OF VALVE SELECTIONS AND MATERIALS FOR DELRAY PLANT OF THE DETROIT EDISON COMPANY

SERVICE							VALVE MATERIALS										
Line	Pres psi Gage	Temp	ASA Std SSP	Ends**	Size, Inches	Type Valve	Body & Bonnet	Disc	Disc Facing	Seat Ring	Seat Facing	Stem	Threaded Yoke Bushing	Packing	Bonnet Bolts	Bonnet Gasket ***	Bonnet Face
Saturated steam and drip, etc.....	950	540	1500	Welding	½-1	Globe, inside screw	Carbon Moly	Stainless Steel	No. 6 Stellite	**** none	No. 6 Stellite	Stainless Steel	Nickel Cast Iron	Carbonite	Alloy B13	Armco Iron	M & F
Superheated steam..	900*	925	900	Welding	4	Globe, OS&Y	C4	Stainless Iron	No. 6 Stellite	Carbon Moly	No. 6 Stellite	Stainless Iron	Steam Bronze	Carbonite	Alloy B13	Monel	M & F
Superheated steam.. and drip, etc.....	900*	925	1500	Welding	½-1¼	Globe, inside screw	Carbon Moly	Carbon Moly	No. 6 Stellite	SAE 4130	No. 6 Stellite	Stainless Iron	AI-1 Alloy	Carbonite	Alloy B13	none	M & F
Superheated steam..	900*	925	900	Welding	4-10	Parallel-slide gate	C4	C4	No. 6 Stellite	Carbon Moly	No. 6 Stellite	Stainless Steel	Steam Bronze	Carbonite	Alloy B13	Monel	M & F
Boiler-feed.....	1200	400	900	Welding	4-8	Wedge gate	Carbon Steel	Carbon Steel	No. 6 Stellite	SAE 1030	No. 6 Stellite	Stainless Iron	Steam Bronze	Carbonite	Chrome Nickel	Monel	M & F
" "	1200	400	1500	Welding	2-8	Wedge gate	Carbon Steel	Carbon Steel	No. 6 Stellite	SAE 1030	No. 6 Stellite	Stainless Iron	Steam Bronze	Carbonite	A96 Class C	Monel	M & F
" "	1200	400	900	Welding	6-8	Horisontal Piston check Vertical Piston check	Carbon Steel	Stainless Iron	No. 6 Stellite	SAE 1030	No. 6 Stellite				A96 Class C	Monel	M & F
" "	1200	400	900	Welding	6	Globe, OS&Y	Carbon Steel	Carbon Steel	No. 6 Stellite	SAE 1030	No. 6 Stellite	Stainless Iron	Steam Bronze	Carbonite	A96 Class C	Monel	M & F
" "	1200	400	1500	Welding	2	Globe, OS&Y	Carbon Steel	Stainless Iron	No. 6 Stellite	SAE 1030	No. 6 Stellite	Stainless Iron	Steam Bronze	Carbonite	A96 Class C	Monel	M & F
Superheater outlet..	900*	925	1500	Sargol	3	Pop safety valve	Alloy Steel	Stainless Steel	none	Stainless Steel	none	Stainless Steel	Copper Nickel Alloy	none	Alloy B13	none	M & F
Saturated drum....	950	540	1500	Serrated raised face	3	Pop safety valve	Cast Steel	Stainless Steel	none	Stainless Steel	none	Stainless Steel	Copper Nickel Alloy	none	Treated Steel	none	M & F
Blowoff.....	950	535	1500	Serrated raised face	1¼	Wedge gate, OS&Y	Carbon Steel	Stainless Steel	none	Stainless Steel	none	Stainless Steel	Modified Monel	Carbonite	Alloy B13	Monel	M & F
Blowoff, instr etc...	950	535	1500	Serrated raised face	1½	Wedge gate, OS&Y	Carbon Steel	Stainless Iron	No. 6 Stellite	18-8 Stainless	No. 6 Stellite	Stainless Steel	Steam Bronze	Carbonite	Chrome Nickel	Monel	M & F
Blowoff.....	950	535	1500	Serrated raised face	1½	Angle blowoff, Duro	Carbon Steel	Stainless Iron	No. 6 Stellite	Carbon Steel	No. 6 Stellite	Stainless Iron	Steam Bronze	Carbonite	Chrome Nickel	Stainless Steel	M & F

NOTE*: Maximum conditions 900 lb, 925 F; normal conditions 865 lb, 910 F.
NOTE**: Welding ends sizes 2½ in. and larger are butt welded; sizes 2 in. and smaller are socket welded.
NOTE***: Gaskets designated "monel" are "profile solid serrated monel" 1/8 to 1/16 in. thick including serrations.
NOTE****: No seat ring; No. 6 stellite seat facing applied directly to body.
Notes on Gasket Material for Line Flanges (Where Used): Boiler-feed, blowoff, saturated steam and saturated steam safety valves, long-fiber asbestos 1/16 in. thick; Superheated steam, "profile solid serrated monel" 1/16 in. thick, superheated steam safety valves .soft iron 0.030 in. thick

very nearly in direct proportion to the water velocity before the sudden stoppage, and amounts to about 60 psi for each foot per second of initial velocity. In a water line working at an ordinary velocity of 10 ft per second a pressure of about 600 psi may develop as a result of water hammer. Obviously then in a 200-lb feed line the water hammer shock may be three times as great as the normal working pressure, thus reducing the factor of safety to only one fourth of its value at normal pressure. In a 1200-lb feed line, however, the water hammer pressure is only one half the normal working pressure and reduces the safety factor to two thirds of its normal value.

The safety factors indicated above are based on the assumption that the pipe material actually furnished will have the tensile strength specified. It frequently turns out, however, that pipe mills furnish material considerably stronger than specified. Advantage of this situation cannot be taken in designing the piping since it is not a guaranteed condition nor is it possible to know at the design stage what the actual strength of the pipe will be. Consequently the piping as actually laid out and erected is quite apt to be stronger than the design would indicate, in some cases adding considerably to the actual safety factor.

Gaskets

Based on experience at Conners Creek it was decided to use long-fiber asbestos gaskets on bolted feedwater connections. Flanged joints having the ¼ inch standard raised face with serrated finish were used for the 1500 lb connection to the economizer, for the 900 lb connections to the boiler-feed pump discharge, for the heater water-box connections, and for other flanged joints in the boiler feed system. Pipe-to-pipe and many pipe-to-valve joints are welded, while ready-made welding elbows and tees are used generally throughout the system.

Valve Seat Rings Welded In

The use of screwed-in seat rings in steel valves for both steam and water has been entirely supplanted by other constructions in the Delray extension. In a few cases, such as the boiler blowoff valves, a hard seating material is applied directly onto the valve port. Seat rings in the turbine emergency stop valve are caulked in. Practically all other steel valves are fitted with seat rings welded into the valve ports. These constructions have eliminated the possibility of leakage between the seat rings and valve body which might have occurred with screwed-in rings loosening in operation through differential contraction and expansion.

Other Piping Systems

The foregoing paragraphs give a rather extensive account of the selections of materials and standards for the boiler-feed and main superheated-steam piping. Other systems which required individual study are the boiler blowoff and high-pressure drip piping. Low-pressure piping such as that for condensate, building heating, general service water, city water, compressed air, and feedwater heater steam piping were selected readily because of the extensive background of experience and Company standards available for those services.

A summary of schedules adopted for pipe, flanges, fittings, and valves in the various services throughout the extension is given in Table IX. A more extensive summary of valve and valve-trim selections for high-pressure service is given in Table X.

Delray Plant

Inspection of Valves and Pipe

THE INSPECTION of all important piping materials in the plant extension was carried on as a routine matter by the Inspection Division of the Company's Purchasing Department. Materials for the high-pressure 925 F steam piping were given an unusually rigorous examination. Inspection of piping for other high-pressure but lower-temperature services, such as boiler-feed, was conducted with equal care, but in this case some of the processes were not witnessed and fewer tests were made.

Valve Inspection

Valve castings were completely heat-treated and inspected in the rough before any machining operations, although earlier practice had been to heat treat after repairing any defects found during inspection. In general the castings were completely cleaned, shot-blasted to remove scale, and ground all over inside and out, prior to inspection. The surface was then visually examined and all defects such as cracks, sand inclusions, and gas pockets were cleaned out to sound metal. Minor cracks and other faults were uncovered by the grinding, which removed the surface crust and exposed unoxidized bare metal. Sections of the casting most likely to be defective were examined with special care.

Sand spots and gas pockets were chipped out to clean metal. Cracks, when found, were removed by grinding since chipping tends to caulk over the cracks, hiding them. Where grinding was too slow, or impossible, a series of small holes was drilled along the crack, each hole being drilled slightly deeper than the crack. The remaining metal was then chipped out to the full depth of the holes. Repairs were made by electric welding using an approved electrode.

The repaired rough castings were stress relieved at 1200 F for at least 4 hr then given a hydrostatic test at several hundred pounds pressure before machining. In some cases this test revealed defects that would have required costly remachining had they remained undiscovered until the final hydrostatic test.

Sand inclusions or other defects that appeared during machining operations were chipped out and welded, followed by another stress relieving operation at 1200 F.

Before the finished valve was assembled the component parts were carefully examined. In this inspec-

TABLE XI. COMPARISON OF CHEMICAL AND PHYSICAL PROPERTIES OF VALVE-BODY MATERIALS USED IN DELRAY EXTENSION

	CARBON-MOLYBDENUM			NICKEL-CHROME-MOLYBDENUM			CARBON STEEL	
	Specified	Average of Separately cast Specimens	Average of Integrally cast Specimens	Specified	Average of Separately cast Specimens	Average of Integrally cast Specimens	Specified	Average of Separately cast Specimens
C	0.15 to 0.30	0.262		0.28 max	0.253		0.15 to 0.35	0.32
Si	0.30 to 0.70	0.407		0.25 min	0.368		0.20 min	0.43
Mn	0.70 max	0.687		0.70 max	0.628		0.50 min	0.744
P	0.05 max	0.030		0.05 max	0.030		0.05 max	0.029
S	0.06 max	0.029		0.05 max	0.028		0.05 max	0.030
Ni				1.05 max	0.963			
Cr				0.70 max	0.647			
Mo	0.40 to 0.60	0.497		0.40 max	0.398			
Yield point, psi	45,000	56,112	54,355	60,000	69,588	67,900	36,000	47,992
Ultimate Strength, psi	70,000	83,107	82,036	85,000	93,828	92,765	70,000	79,087
Per cent Elongation	22.0	25.4	24.8	20.0	23.4	23.5	22.0	28.3
Per cent Reduction of Area	35.0	49.6	45.3	35.0	50.9	49.5	35.0	44.7
Charpy V-Notch	25.0	30.0	34.3	30.0	38.0	40.9		

tion special attention was given to valve stems, discs, and seats. Final inspection consisted of witnessing the hydrostatic tests followed by checking the valve for dimensions, location of drilled bosses, packing, lubrication fittings, freedom from machine cuttings, and so on. Hydrostatic tests of the valve bodies were made with cold water at the pressures called for by the Code for Pressure Piping. The seats were tested at 1½ times the rated working pressure.

Melt numbers of each body and bonnet were taken from the valve and the chemical analysis and physical properties of those melts were checked against the requirements of the specifications. As a result complete data on all valves are readily available. The average chemical analysis and physical properties of several recent melts are given in Table XI.

Piping Inspection

The inspection of steel pipe offered no particular difficulty beyond those problems encountered in the inspection of pipe for Conners Creek. Carbon-molybdenum pipe for main steam line use was given extremely careful inspection because of the amount of working to which it is subjected during manufacture. This pipe, bought to ASTM specification A206, was called upon to meet all the regular

TABLE XII—COMPARISON OF CHEMICAL AND PHYSICAL PROPERTIES OF PIPE MATERIAL USED IN DELRAY EXTENSION

	Carbon-Molybdenum		Silicon-killed Carbon	
	Specified	Average Specimen	Specified	Average Specimen
C	0.10 to 0.20	0.128	0.35 max	0.266
Mn	0.30 to 0.60	0.44	0.75 min	0.94
P	0.04 max	0.012	0.04 max	0.021
S	0.05 max	0.018	0.06 max	0.027
Si	0.10 to 0.25	0.174	0.15 min	0.22
Mo	0.45 to 0.65	0.51		
Al	0.02 to 0.06	0.033	0.06 max	0.03
Yield Point, psi	30,000	43,200	35,000	52,242
Ultimate Strength, psi	55,000	62,164	62,000	79,900
Per cent Elongation	25.0	43.9	20.0	35.0

and supplementary requirements of that specification. Killed-carbon-steel pipe for boiler-feed lines was bought to ASTM specification A106, including supplementary requirements for sizes over 6 in. Actually less trouble was encountered than previously in making the supplementary tests, probably due to the fact that more consumers are requesting them now than heretofore.

The inspection of all pipe was expedited by either pickling or shot blasting both the inside and outside surfaces. Where pickling was used the examination followed immediately. In either case all scale was removed and the clean bare metal exposed. Each piece of pipe was numbered and the ends identified. Physical properties and chemical analysis were determined for each end of each piece of pipe in the more important services and recorded against the identifications. As in the case of valves this record is available for use in future studies and investigations. Average chemical and physical properties of a number of recent melts of carbon-moly and killed-carbon steel for pipe are given in Table XII.

Fabrication of the pipe also was inspected, and in many cases the actual bending operations were witnessed. After stress relieving, the bends were again cleaned and finally inspected for defects, dimensions, and workmanship.

Delray Plant

Piping Layout

ALL PIPING systems in both sections of Delray are laid out with due consideration of several basic requirements, but during the ten year interval between construction of the two sections, developments have been made which result in arrangements of pipe lines in the new section that are quite different from older designs intended to serve the same purpose.

In the order of their importance the following fundamental principles of design are kept always in mind:

(a) The piping must function properly and efficiently with respect to the equipment it serves;

(b) The piping must be arranged for convenience in operation with all valves so located as to make their functions evident to the operator. This is accomplished by locating the valves in a symmetrical arrangement with respect to equipment and building steel as discussed under "Duplication of Equipment and Layout."

(c) The piping must present a pleasing appearance, consistent with the general design of the plant.

Main Superheated-Steam Piping

The main superheated steam piping in the older section of Delray is laid out in the form of a multiple-ring header, providing numerous paths through which steam can flow from any boiler to any turbine. Each boiler is connected to the ring through its own boiler lead, and turbine leads are taken off at separate points along the side of the ring nearest the turbine room. This arrangement is shown in the right-hand portion of Fig. 40. The obvious advantages of this layout are its extreme flexibility in operation and its low pressure drop under normal conditions. In cases of valve trouble in the header it is possible to isolate any valve for repairs without having to shut down the boiler or turbine equipment adjacent to it. Of course, if the valve in trouble happens to be in a turbine lead or boiler lead it becomes necessary to shut down that particular turbine or boiler, but nothing else is involved.

On the other hand there are some serious drawbacks to the multiple-ring layout. Such a header is expensive to build because many valves are required, in addition to the large amount of extra pipe used in cross-overs. If the system is to operate within reasonable pressure-drop limits under adverse circumstances involving shut-down of boilers and turbines in opposite ends of the plant, for example, the piping must be larger than needed for a boiler-turbine unit layout. The reason for this is that under such circumstances it is necessary to force through some particular section of the header an amount of steam very much greater than the capacity of one boiler. While such a section may be quite short, the steam velocity is very high and the pressure loss excessive. Since the header is open all the way through, any excessive pressure drop in one section carries on through the entire header, resulting in low efficiency so far as delivery pressure is concerned. In order to minimize this loss it was necessary to use 16-in. pipe and valves throughout the main steam system. With large piping installed

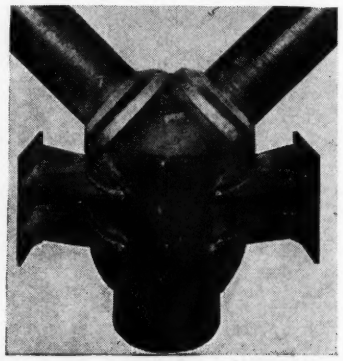


Fig. 41. Welded steel Y-fitting with anchor pads attached

to meet the adverse conditions assumed in design, the pressure drop in normal operation is relatively low, thus partially offsetting the disadvantages. Also, since the low-pressure header is only half complete with respect to the original layout, there actually is a lower pressure drop in the header than was intended when the design was made.

In contrast with the steam layout just described, the main superheated steam piping in the Delray extension is arranged on the general plan of the boiler-turbine unit system. The desirability of this plan from an economic standpoint has long been recognized but has become feasible only in recent years as a result of greater reliability of steam-generating equipment and freedom from pipe line difficulties as a result of the elimination of flanged joints by substituting welded construction.

The left-hand part of Fig. 40 shows the arrangement of the main steam piping in the extension. Steam leads consisting of 10-in. and 12-in. pipe from each

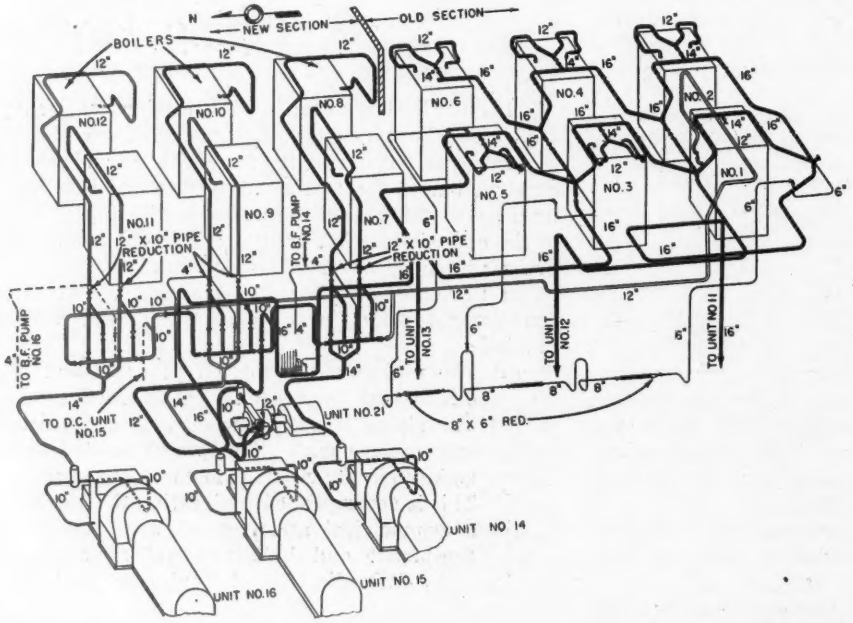


Fig. 40. Diagram of main steam piping in Delray PH 3. Right-hand portion shows piping in low-pressure section. Left-hand portion shows piping in the plant extension

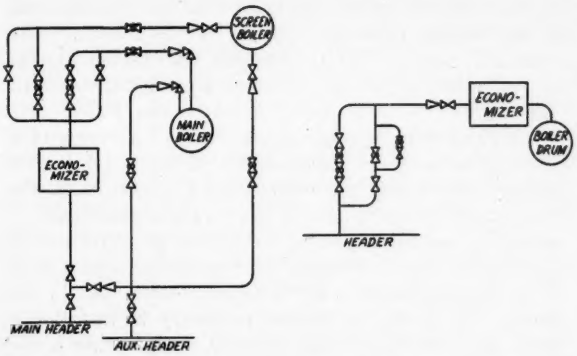


Fig. 42. Diagram of feedwater piping for one low-pressure boiler
Fig. 43. Diagram of feedwater piping for one high-pressure boiler

of two boilers are tied together by means of a specially constructed Y fitting, shown in Fig. 41, and pass their steam to one turbine through a 14-in. turbine lead. This layout is repeated for each of the three pairs of boilers and three turbines. At this point the resemblance to the boiler-turbine unit plan ends, for each of the boiler leads also is connected to a 10-in. header. The ultimate plan calls for making this header into a ring, as indicated in Fig. 40, to receive steam from a seventh high-pressure boiler to be installed in the number 1 position if and when it becomes desirable to do so. In addition to this function of the header, a reasonable amount of steam can be transferred through it, when the occasion arises to compensate for outage of any high-pressure boiler, and it serves also as a source of steam for the turbine-driven house-service generators as well as for the emergency boiler-feed pumps and other steam-driven auxiliaries. Since these steam-driven units are required especially in emergencies it is believed essential that their steam supply be made available from all the boilers. The decision to install a 10,000-kw superposed turbine using over 500,000 lb of steam per hr also necessitated some deviation from the straight boiler-turbine unit scheme. The superposed machine will take its steam from the header. As indicated above, a substantial quantity of steam can be transferred crosswise of the plant through the header with a moderate pressure drop. It is not planned, however, to carry the full-load steam supply for one turbine through the header.

Another departure from the low-pressure design concerns the total pressure drop between the boilers and turbines. In the older section the steam piping was designed for an overall pressure drop of only 30 psi under adverse conditions of flow because the inherent limitations of riveted boiler drums emphasized the need for conserving pressure. It is a rather simple matter, on the other hand, to build a welded boiler drum for a few pounds greater working pressure, and in the plant extension the allowance for pressure drop has been stepped up to 50 psi. This advance in boiler practice is reflected, therefore, in a more economical piping layout.

The use of 12-in. boiler leads with subsequent reduction to 10-in. size requires some explanation. The smaller size is used for reasons of economy, not only in the carbon-moly pipe but also in the chrome-nickel-moly valves, all of which are 10-in. size. The 12-in. section of boiler lead was installed to provide for proper and economical metering of the steam flow as discussed at length in "Mechanical Engineering" for November, 1938.* Two conclusions from that discussion are as follows:

1. If accuracy within plus or minus 2 per cent is desired a suitable nozzle or orifice-plate diameter ratio should be selected to insure constant flow-coefficients over the operating range of the meter. D_2/D_1 should not exceed 0.75 and preferably should be under 0.70.
2. The section of piping in which the primary element is installed should provide sufficient straight pipe upstream and downstream from the nozzle or orifice plate to insure freedom from swirls or eddies in the steam flow. If there is doubt as to whether undisturbed flow is obtained, straightening vanes should be used in addition to the minimum lengths of straight pipe.

In addition to the meters installed in the long horizontal run of 12-in. pipe in each boiler lead there also is one in the vertical run of each 14-in. turbine lead.

Boiler and turbine stop valves and header division valves normally are closed by hand, but in emergencies they may be closed by motor operators controlled from a remote station accessible to both the operating and basement floors. On the other hand all valves must be opened manually to insure equalizing the pressure when placing a line in service, and to minimize the possibility of opening a valve by mistake.

Boiler-Feed Piping

Boiler-feed piping in the plant extension presents

*"Influence of Steam Flow Metering Equipment on Piping Design", by R. M. Van Duzer, Jr. Mechanical Engineering, Vol. 60, No. 11, November, 1938, p. 834.

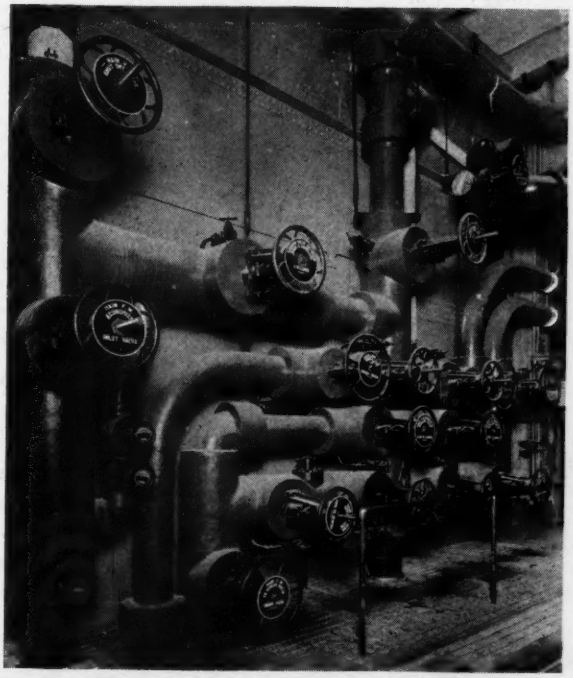


Fig. 44. Photograph of "valve nest" on low-pressure boiler

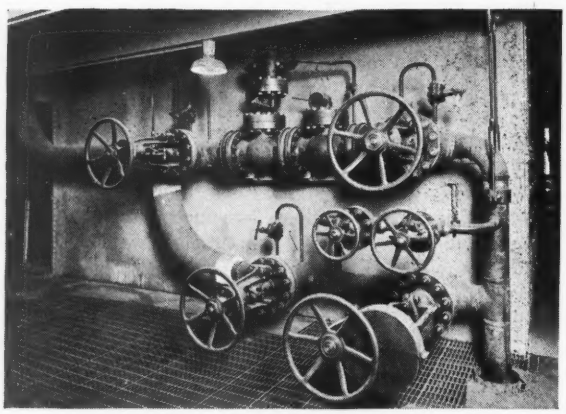


Fig. 45. Photograph of "valve nest" on high-pressure boiler

an outstanding example of simplification as compared with the older section of the plant. Schematic diagrams of the feed systems presented in Figs. 42 and 43 for the old and new sections, respectively, illustrate the great difference between the two. Two major factors which contribute to the improvement in boiler-feed layout are:

1. Substitution of a ring header with single risers for the older duplicate header and duplicate riser arrangement; a change made feasible by the development of reliable welded construction.
2. The integration of water wall and convection-boiler circulation systems as compared with the separate feed systems for screen-boiler and convection boiler in the older units.

For reasons of reliability in feedwater supply to the boilers, it was considered necessary, in the 375-lb section of the plant, to install duplicate boiler feed systems all the way from duplicate pumps to separate feed connections on the boiler drums. Both of these feed systems were so connected that the boilers could be fed either automatically or by hand from either feedwater source. With separate circulation systems in the main boiler and screen boiler, much of the valving had to be installed in duplicate. Feed valves are arranged in groups called "nests" at the end of the coal bunkers at the elevation of the water tenders gallery where they are convenient for operation. One "nest" serves one boiler. Figure 44 is a photograph of the valve nest arrangement in the low-pressure section.

By the time Conners Creek was modernized a study of operating history in Detroit Edison plants had shown that it was no longer necessary to install complete duplicate boiler-feed systems. A growing knowledge of the behavior of pipes undergoing thermal expansion had resulted in designs which limited the bending stresses at bolted joints, minimizing failures of that nature. Improvements in valve design and manufacture had reduced the likelihood of shut down as a result of valve failures. The development of a reliable welding technique further increased the freedom from leakage at pipe-to-pipe and pipe-to-valve joints. It was decided, therefore, to design the feed piping on a simplified plan, eliminating as much duplication as would be consistent with a high standard of reliability. The resulting design for Conners Creek plant has worked out so well that the same basic principles are carried over into the Delray extension.

By arranging the header in the form of a ring it is possible to feed any boiler from either direction around the ring, thus providing the two sources of feedwater called for by the ASME Boiler Code. At the same time only a single riser from each main unit is needed to supply the ring. With all riser joints strength welded, each of these lines is essentially a single continuous piece of pipe from the outlet of the last feedwater heater to the feedwater regulating valves. Duplication of risers to insure reliability is believed unnecessary.

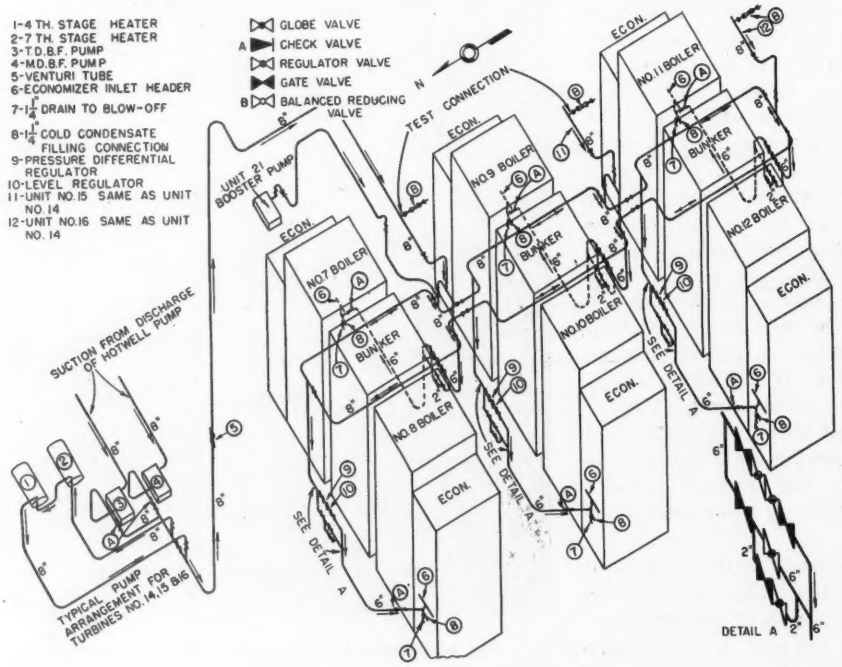


Fig. 46. Diagram of boiler-feed piping in plant extension

Each boiler is connected to the ring header through a single line which supplies water through the valve nest to the economizer inlet. The boiler circulation system, described in the May issue of POWER PLANT ENGINEERING, is common to both the convection boiler and water walls. Therefore, only one set of feedwater regulating valves per unit is required. The outstanding simplification of the feed valve nest shown in Fig. 45 is evident on comparison with the valving on the older boilers as illustrated in Fig. 44. A pictorial diagram of the ring header, risers, and boiler connections in the plant extension is presented in Fig. 46. If and when a seventh high pressure boiler is installed in the number 1 position at the north end of the plant it will be necessary to connect into the north end of the ring header for its supply of feedwater.

LOW-PRESSURE AND TEMPERATURE SYSTEMS

There are a number of low-pressure and low-temperature systems that may well be considered together from the viewpoint of layout. In one group are general service water, compressed air, city water, auxiliary dry-vacuum, building heating, and oil lines. Another group consists of headers for hot drips, main dry vacuum, condensate, and sealing water. All of these are simple straight headers running lengthwise of the plant in groups of parallel lines at an elevation of approximately 11 ft above the condenser room floor. Expansion is accommodated by either corrugated or slip-type joints wherever needed.

Sources of supply are connected to the respective headers at appropriate points along their length and branches are taken off to the several points of use. Insofar as possible all branches connecting to or leading from the headers are run at the same elevation, making for good appearance and accessibility. In the case of the general service header, branches are taken off at each end to supply another header furnishing water to the main unit transformers at the opposite side of the turbine room, thus effecting a ring header arrangement.

Photographs of these piping groups are reproduced in Fig. 37 on the first page of this installment, and in Fig. 47. It is in such compact arrangements as these that piping designers are called upon to exercise a good bit of ingenuity in avoiding interferences and working out a neat, orderly, and accessible layout.

DUPLICATION OF EQUIPMENT AND LAYOUT

For many years it has been Detroit Edison practice to install similar units in identical arrangement in any one plant. Advantages of this practice are manifold, and almost at once apparent. It not only reduces the overall designing labor, but at the same time permits concentrating on the development of the best possible layout for one unit, knowing that essentially the same design will be suitable for additional units. From the operating standpoint a repetition of layout makes it possible for the operators to know the entire plant by learning the layout of only one unit, since any given valve or other device will have the same relative position and function on every unit.

The use of models has been most helpful in studying complicated piping layouts, and where an arrange-

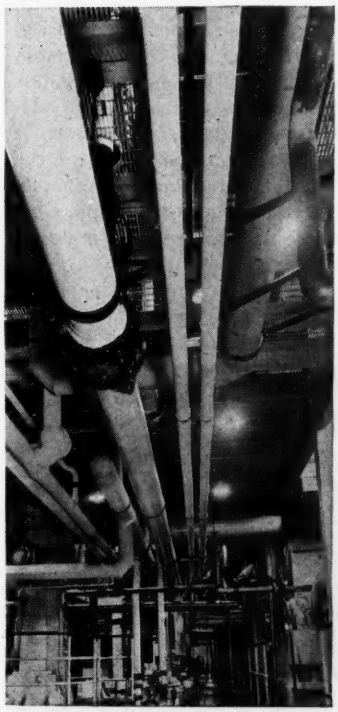


Fig. 47. East header gallery in condenser room, showing vacuum, hot drip, and sealing-water headers

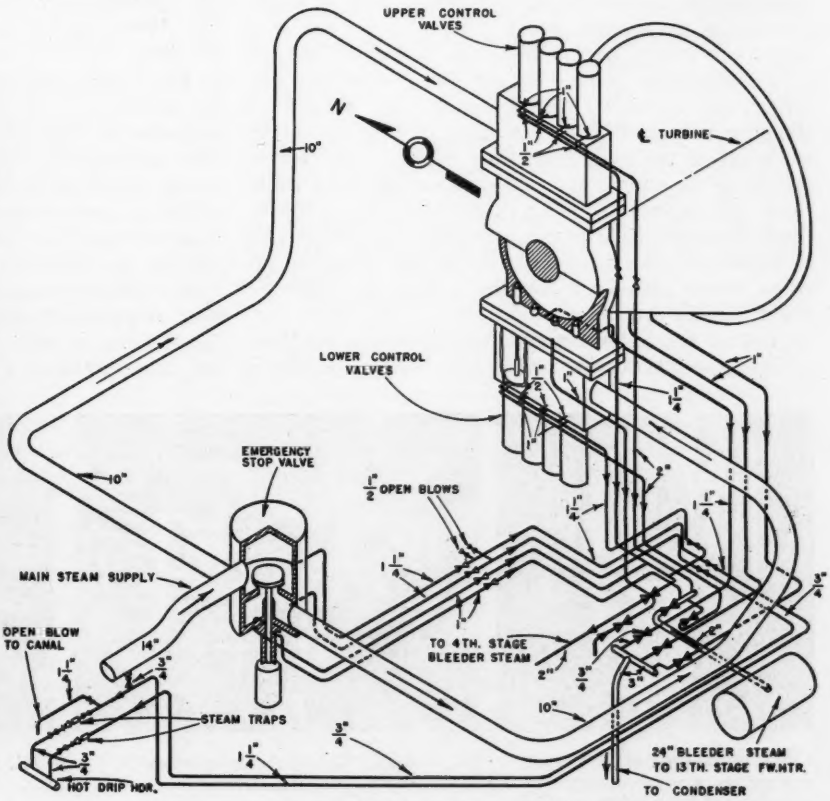


Fig. 48. Diagram of drip piping around 75,000-kw. turbine

ment is to be repeated a number of times the expense involved in making the models is amply justified.

Some deviation from the repetition principle is, of course, necessary with respect to the two sections at Delray. In either section, however, repeated layouts are to be found, and in many services the same arrangement will be found throughout the plant.

Drip Piping

Drip piping, installed to collect and dispose of the condensate that accumulates at various points in the steam piping systems, is one of the least imposing and at the same time one of the most important systems in a steam power plant. Consisting for the most part of small size lines it usually is obscured by larger pipes, building steel, or plant equipment. Many operating troubles are traceable to drip piping that fails to perform as it should, and the function is, of course, an important one.

The use of pipe bends and welding has simplified the construction and improved the appearance of the drip system itself, and the adoption of welded manifolds in place of the older style of cast fittings used where steam lines come together, has reduced the number of drainage points. Even so, the drip system is quite extensive, as typified by the drain lines needed on the 75,000-kw turbine, shown in Fig. 48.

After long experience with conventional traps it was decided to experiment at Conners Creek with a multi-stage orifice arrangement which, when open, would pass a certain amount of steam if the line were dry and a considerably larger weight of water when condensation occurred. As compared with a single orifice, the multi-stage design permitted the use of a larger size hole in each orifice plate than could be used in a single-stage orifice for the same capacity. The larger size openings are, of course, less subject to clogging with mill scale or other dirt which might work out of the lines from time to time. On test at 600 psi g the multi-stage orifice passed about 14 times the weight of water at 350 F that it did steam at 700 F. Since the steam leakage was considered reasonable and because the orifice gave less trouble than conventional traps, it was planned to use the multi-stage orifice on drain lines in the Delray Extension.

Before the latter designs were complete an "impulse" trap, also of the orifice type, became available and was put on test at Conners Creek. This trap, when properly adjusted, had a ratio of water to steam capacities of about 85 to one, a decided improvement over the performance of a plain or multi-stage orifice. Following the capacity test, the trap was put into regular operation for further observation over a reasonable period of time and finally was selected for service at Delray. Typical of the use of the impulse trap is the installation shown in Fig. 49, at the lower end of the steam lead to the 75,000-kw main turbo-generator.

Condensate Piping

Condensate piping comprises that section of the feedwater circuit between the condenser hotwell and boiler feed-pump suction, plus the piping and equipment used to drain condensate from the feedwater heaters. Pressures and temperatures are relatively low, that is within the range of 250 psi g and 400 F. The main problem here is to secure an orderly and convenient arrangement of piping and valves in a small space since the condensate and boiler-feed pumps are located directly beneath the feedwater heaters. What has been accomplished in this respect is indicated in Fig. 50 showing some of the condensate piping between the hotwell pump and the main condenser. Welding fittings played an important part in permitting a clean-cut, compact arrangement of this piping although many flanged connections also are to be found in the condensate system.

Bleeder-steam Piping

Bleeder-steam piping presents some interesting layout problems because the lines are relatively large, quite short, and as a result fairly stiff. In the high pressure extraction line steam temperatures as high as 625 F are encountered at pressures up to 200 psi g. In the lowest pressure extraction line the maximum temperature is less than 180 F and the pressure is less than atmospheric. It was not possible to obtain adequate flexibility through directional changes because of the limited amount of space and large size of the lines, although the layout takes advantage of as much natural flexibility as the available space permits. Corrugated expansion joints are used wherever it is necessary to provide supplementary flexibility.

Welding is used extensively in the bleeder lines, not only because it permits a better layout but also to

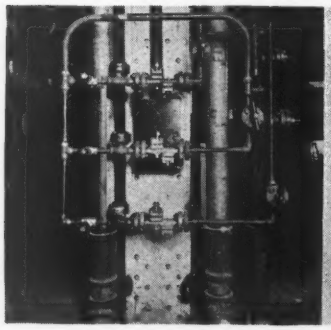


Fig. 49. Installation of "impulse" traps on emergency stop valve, boiler-feed-pump turbine, and 200-lb saturated steam line

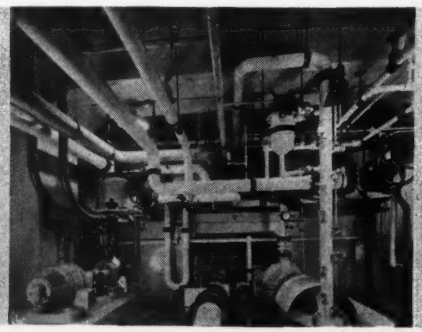


Fig. 50. Condensate piping around 75,000-kw. turbine

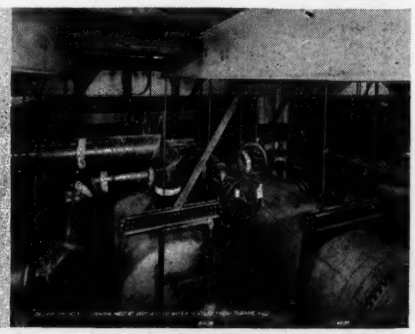


Fig. 51. Construction view of bleeder-steam piping from 75,000-kw. turbine

minimize the number of bolted joints where leakage might occur. This is especially important in the lines operating under vacuum since an in-leakage of air is detrimental to the cycle efficiency and contributes undesired oxygen to the boiler feedwater. The photograph reproduced in Fig. 51 shows some of the bleeder lines during erection of the first 75,000-kw unit.

Delray Plant

Fabrication of Piping Systems

THROUGHOUT the preceding pages of this installment frequent reference has been made to the use of welding and the advantages gained thereby. The welding of 10 yr ago was of uncertain quality, and its use in the first section of Delray was limited to low-pressure service such as the building-heating system, roof-drain piping, and so on.

Progress in welding during recent years has been rather completely reported in the technical press from time to time and it is not desired to repeat that information unnecessarily in this account. For the purpose of completeness, however, some detail of Detroit Edison welding practice is given below, together with contrasting examples of fabrication methods as found in the new and old sections of the Delray plant.

Development of Welding Technique

Realizing the importance of reliability where welding is used, a specific and thorough procedure has been established for qualifying the men who make the welds and for the program they follow in doing their work. To produce a sound weld requires a special skill and a steadiness of hand which not all men possess, and which is acquired only after extensive practice. Although a welder's performance is not particularly analogous to that of a musician, the degree of muscular control required to produce an acceptable weld for severe service is just as great as that needed for a finished musical rendition.

A series of tests has been designed to find out what men have sufficient skill to be entrusted with the making of important welds. Each candidate for high-pressure pipe work is required to make two welded joints on pipe having a wall thickness exceeding one half inch, using the same brand of electrode as is to be used in the field. Both welds are made on sample pipes in fixed positions, one with its axis horizontal and the other vertical. Ten coupons cut from each weld and tested after all the weld reinforcement has been removed must meet the following requirements. These tests conform with the requirements of paragraph P-112 of the ASME Boiler Code and qualify the welding process as well as the operators. For the welding of low-pressure pipe the same process is used but the operators are qualified on their ability to satisfy the soundness tests called for in the American Standard B-31.

Number of Coupons	Test	Requirements
2	Reduced-Section Tensile	Must at least equal the minimum specified tensile strength of the pipe.
2	Free-Bend	Elongation of outer fibers not less than 30 per cent.
2	Side-Break	Not more than six faults per sq inch of exposed surface, none of which shall exceed $\frac{1}{16}$ in. in any dimension; or the total area of defects shall not be greater than the area of six defects each $\frac{1}{16}$ in. in diameter.
2	Nick-Break	
2	Etch	

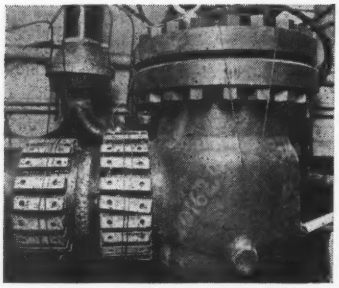
All welds, whether made in the field or on qualification tests, are made by the direct-current metallic-arc process, using coated electrodes. The welding machines are of the single-operator type permitting each operator to adjust the arc to conditions most suitable for the work in hand.

For at least two reasons it has been found desirable to build up a weld in layers not more than $\frac{1}{8}$ in. thick. One reason is that by restricting the depth of a single deposit the depth of any possible fault also is restricted. At the same time a larger number of layers increases the probability that such faults as may exist will be found and corrected. This advantage of the built-up weld of course necessitates correcting surface defects and removing from each layer the slag deposited from the electrode coating as the welding progresses. On welds in high-pressure lines the cleaning of each layer is carried out by the welder's helper, thus eliminating arm fatigue that would be induced if the welder himself had to do the cleaning. The second reason for depositing the weld in layers is that each subsequent layer heats and refines the grain structure of the preceding layers, producing physical properties in the weld metal that are far superior to those in the "as deposited" condition.

Arcronograph Records Welding Conditions

A vacuum tube instrument called the "Arcronograph" has been used at Conners Creek and in the Delray Extension to make a graphical record of the conditions under which each bead of every important weld was laid. The instrument actually records the ratio of arcing time to short-circuit time as each globule of weld metal is deposited. With a given type and size of electrode this ratio is essentially constant in an acceptable weld. Permissible limits of the ratio are determined on test welds and the record is then observed for deviations beyond the allowable range. A succession of deviations outside the predetermined range is cause for suspicion and examination of that portion of the weld. Experience has led to the belief that for field welds the arcronograph record gives a reliable indication of the uniformity of workmanship.

Aside from its psychological effect on the welder the arcronograph has the advantage of providing an instantaneous record as the welding progresses. Ordi-



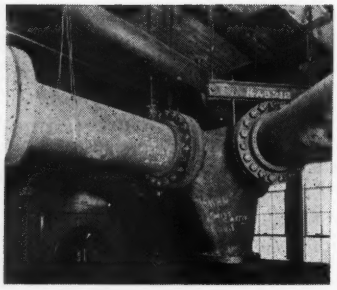
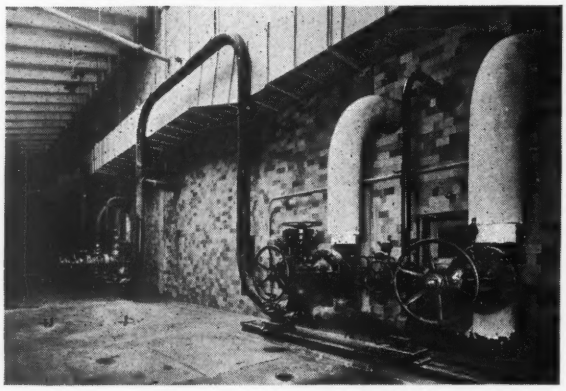


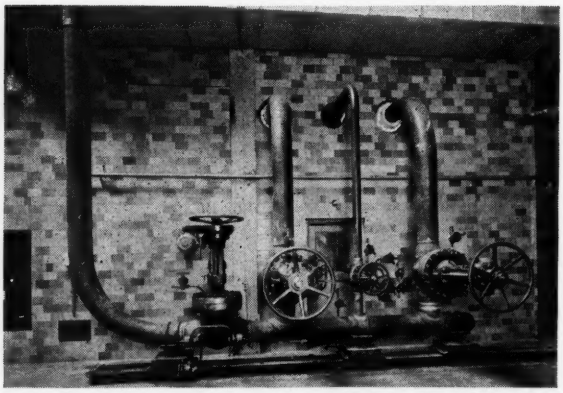
Fig. 52. Resistance preheaters installed on 10-in. carbon-molybdenum welded joint at superheater-outlet valve

Fig. 53. Five-way steel casting used in 400-lb main steam piping 10 yr. ago

Fig. 54. Welded-steel manifolds and expansion loops in main steam system in plant extension

Fig. 55. Arrangement of valves and anchors at main steam manifold





narily radiographs would not be made until the weld is completed. Obviously less chipping is required in correcting a fault if the defect is found immediately than would be necessary if the fault were covered by several subsequent layers of weld metal.

Stress Relief

Stresses set up in welding are relieved by subsequently heating the area of the weld to about 1200 F, holding that temperature for one hour per inch of wall thickness, and then slowly cooling. This heat treatment is accomplished by means of a specially constructed electric induction heater consisting of a helical coil clamped around the pipe but insulated from it electrically. When the coil is energized with alternating current from a special transformer the pipe itself becomes in effect a one-turn secondary of a transformer of which the helical coil is the primary, and the pipe in the area of the weld becomes hot.

Although necessarily rather high in first cost, the induction annealer is an economical device where a large number of welds are to be stress relieved. It has additional advantages over some other methods in its adaptability, portability, cleanliness, ease of installation, and accuracy of control.

Preheaters for Carbon-Moly Pipe Welds

The welding and stress-relieving operations outlined above constitute the welding process as applied to medium-carbon pipe joints and to joints between medium-carbon pipe and nickel-chrome-moly valves.

In the case of welding joints between sections of carbon-moly pipe or between carbon-moly pipe and nickel-chrome-moly valves there is, however, a tendency for cracks to form in the weld metal before it can be stress relieved. This comes about through the air hardening influence of molybdenum, or other alloying elements, in conjunction with high carbon. Two steps taken to insure sound welds in these mild alloy joints are: (1) to keep the carbon content below 0.35 per cent and preferably below 0.20 per cent; and (2) to preheat the parts being joined before the actual welding is started and to maintain supplementary heating during the welding process.

At Delray a suitable preheat temperature of from 400 F to 600 F is attained by the use of electric-resistance heating elements clamped around the ends of the parts to be joined. The entire area, including the resistance heaters, is wrapped in an asbestos blanket and current is then applied until the joint is hot enough to begin welding. The joint is then welded using an arcronograph to produce a record of the welder's work; after which stress relieving is carried out as described above. On most joints, with the exception of small ones, it is necessary to keep the preheaters in service during the welding operation to prevent too rapid loss of heat from the deposited metal to the relatively cold mass of pipe. The preheaters are not kept on during the night or over week-ends, however, even though the particular weld may be only partially completed at the time. Figure 52 shows the joint between the superheater outlet valve and boiler lead with the preheaters in place.

Backing Rings and Socket Joints

Full strength butt welding requires penetration of the fusion zone to the inside of the pipe wall. For this reason the ends of adjoining parts are beveled to receive weld metal throughout the entire wall thickness. For sizes 2½ to 5 in., inclusive, each pipe end is beveled at 37½ degrees. On sizes 6 in. and larger some special bevels have been used, but in the future these

sizes will be beveled as recommended by ASA Sectional Committee B-16. Thin steel bands called backing rings are inserted in the pipe ends directly underneath the joint to permit complete penetration of the weld without burning the ends of the bevels and to prevent the formation of "icicles" and weld spatter inside the pipe.

In the case of welded joints on lines of 2 in. diameter or smaller, backing rings are believed to offer too much restriction to flow and welds of the socket type are used to accomplish the purposes of a backing ring. Figure 49 showing an installation of impulse steam traps also is an excellent illustration of the use of socket-welding fittings.

Substitution of Welded Units for Cast Fittings

The development of a reliable welding technique resulted directly in the simplification of piping detail and indirectly in piping layout.

In the low-pressure main steam system, for example, special fittings of cast steel were used to connect the various portions of the header piping and to provide take off points for the turbine leads. One such fitting with connecting pipes is shown in Fig. 53. Portions of the header piping connect into the horizontal branches of these fittings while the turbine lead connects to the lower end of the vertical branch. All branches come together in an enlarged section designed to reduce the velocity, and therefore pressure drop, as the steam flows through the fitting. This construction compares directly with the welded Y-fitting used in the plant extension to combine the 10-in. leads from two boilers into one 14-in. turbine lead as shown in Fig. 41. The new steam header consists of all-welded manifolds joined by sections of pipe in the form of expansion loops as shown in Fig. 54. One manifold is installed with each battery of boilers and provides a convenient place to locate all the header valves needed for that boiler battery. The neat appearance of the valve arrangement made possible by welding is indicated in Fig. 55.

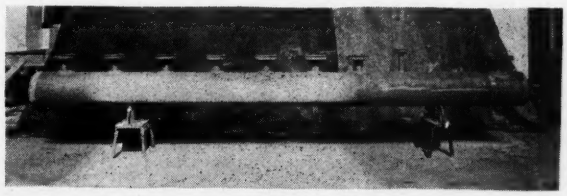


Fig. 56. Welded-steel relief valve manifold for superposed turbine exhaust

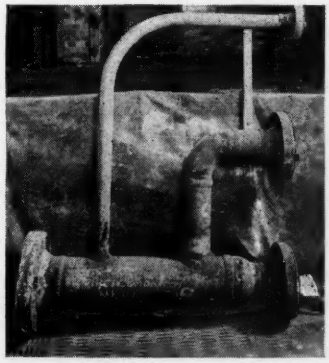


Fig. 57. Welded-steel pipe combination for superposed turbine exhaust during starting and stopping operations

Another example of compact piping layout is the boiler feed valve nest as indicated by comparing Figs. 44 and 45. Aside from the greater number of valves used on the old layout, note the number of flanged joints in comparison with the valve nest designed for the plant extension. Here the only flanged valves are those used for automatic boiler-feed regulation.

More examples of welded units are shown in Figs. 56 and 57. A unit not shown is a welded Y-fitting in which the branches are the leads to the two throttle valves of the 10,000-kw superposed unit. Steam will be brought to the machine through a 14-in. lead from one of the main steam manifolds. This Y-fitting divides the supply just ahead of the turbine. The units shown in Figs. 56 and 57 will be used in the exhaust piping attached to the superposed machine. It is necessary to protect the machine casing against excessive exhaust pressure by means of safety valves which will be arranged on the manifold shown in Fig. 56. The other unit is a special pipe combination that will be fitted with valves used in exhausting steam to atmosphere during starting and stopping operations. In this case particularly, it is interesting to imagine what the arrangement would be like were it made up of flanged fittings.

Delray Plant

Anchors, Hangers, and Sway Bracing

THE DESIGN of piping for flexibility starts with the assumption of certain anchor points which divide the line into sections as far as expansion is concerned. Between anchorages, the line is supported in such a way as to permit relatively free movement in all directions.

Anchors

Several anchoring arrangements have been used at Delray. In the older layouts using cast fittings, anchors frequently were provided by casting a pad on the fitting in such position that it could be bolted to the building steel. Welded fittings are similarly anchored by welding pads to the fitting as shown in Fig. 41. These pads may be either bolted or welded to the building steel. Another type of anchor is visible in Fig. 55. Here the main steam manifold is clamped to three supports carried on beams fastened to the floor. In this particular case the middle support anchors the manifold against longitudinal movement although it does allow motion at right angles to the manifold. The two end supports are designed to permit both longitudinal and transverse movement of the manifold.

Hangers

Various styles of hangers are employed to support the piping between anchor points. The simplest, consisting of a plain rod and clamp, is used on lines operating at relatively constant temperature and not subject to appreciable expansion movements. In cases

where considerable movement takes place, it is necessary to support the piping on spring hangers of either plain or toggle design, sometimes mounted with traveling buggies on rollers. A new style plain spring hanger with inclosed coils is illustrated in Fig. 58 showing an application to a vertical boiler-feed riser. In the older style the spring was exposed. The new design is not only neater in appearance but is functionally better since the hanger rod proper is free to move laterally within the coil. Of equal importance is the fact that the new type is less expensive to build since it is fabricated by welding from scrap ends of pipe. On vertical lines, such as the one illustrated, the pipe clamp to which the hangers are attached is fastened to the pipe by tack welds, which eliminates the need for the more costly friction clamps formerly used.

In some cases a hanger is desired that will provide essentially constant support throughout a wide range of deflection. The toggle hanger meets such requirements because the relationship between the force of the spring and the angle between the load and the line of action of the spring produces practically constant support over the working range of the hanger. Figure 59 is an illustration of such a device together with a graph of its load deflection characteristic.

Sway Bracing

Long runs of pipe floating on spring supports sometimes begin vibrating because of fluctuating flow or for other indeterminate reasons. At times the amplitude of vibration becomes serious, and unless steps are taken to steady the piping, stresses of unknown severity may be set up in the lines.

In an effort to guard against damage as a result of vibration it is good practice to install double-acting "sway braces" between the building steel and piping at locations where excessive vibration otherwise might be expected. Even then additional braces may be found necessary after a line has gone into operation. An installation of sway braces on a 90-degree bend in the new boiler-feed piping is shown in Fig. 60. These braces consist of pipe and springs, and are hinged at either end to brackets which are in turn welded to the building steel and to the pipe, respectively.

The following bibliography which has been drawn upon extensively in preparing this account is offered for those who may be interested in further details of the piping practice described in this article.

"Modern Practice in Piping Design", by Sabin Crocker, Heating-Piping and Air Conditioning, January 1938.

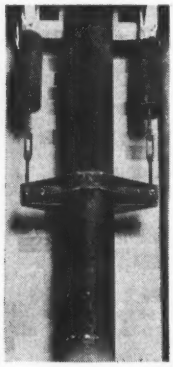
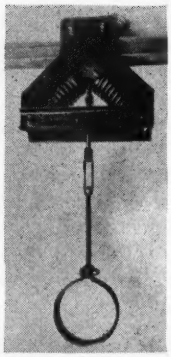


Fig. 58. Installation of spring hangers on boiler-feed riser



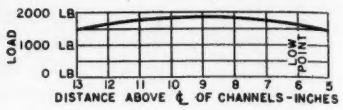
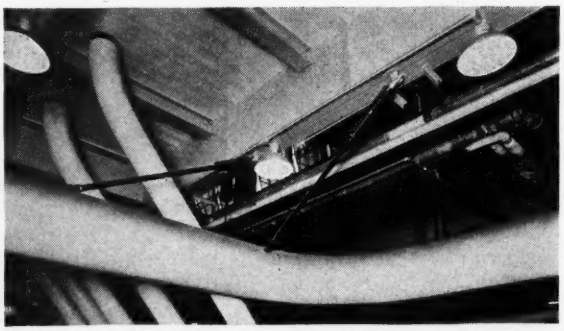


Fig. 59. Constant support toggle hanger and load-deflection curve

Fig. 60. Double-acting sway braces on 10-in. boiler lead



"An Examination of Welds Made Under Field Conditions for High Pressure, High Temperature Steam Station Piping", by A. E. White, D. H. Corey and C. L. Clark, Journal, American Welding Society, September 1934.

"Welding High Pressure, High Temperature Steam Piping", by Sabin Crocker, Heating-Piping and Air Conditioning, February and March 1935.

"Welded Fabrication of Manifolds and Special Fittings for Piping", by Sabin Crocker, Heating-Piping and Air Conditioning, January 1937.

"Modernizing the Conners Creek Power Plant", by Sabin Crocker, Combustion, March and April 1936.

"Arc Welded Piping in Central Station Steam Plants", by C. F. Hirshfeld and D. H. Corey, Advance Paper, Society of Naval Architects and Marine Engineers 1936.

"Grading Welders", by D. H. Corey, Power, July 1938.

"Welding Carbon-Moly Pipe at Delray", by Sabin Crocker, Heating-Piping and Air Conditioning, January 1939 and February 1939.

"Fabrication Details for High Pressure and Temperature Piping", by Arthur McCutchan, Heating-Piping and Air Conditioning, March and April 1939.

"Dripping High Pressure High-Temperature Steam Piping", by Arthur McCutchan, Heating-Piping and Air Conditioning, August 1938.

"Influence of Steam-Flow Metering Equipment on Piping Design", by R. M. Van Duzer, Jr., Mechanical Engineering, November 1938.

The next installment, to be published in the September issue, will discuss the choice of plant operating cycle, auxiliary system, feed pump selection and drive, feedwater heaters, condensers, and their auxiliaries.

The PRACTICAL ENGINEER

DEVOTED TO PLANT OPERATION and MAINTENANCE

A. W. KRAMER, EDITOR

EASY TO LOOK AT

IN PRESENTING the initial section, The Practical Engineer, we are printing it on a slightly yellow stock which many people feel is "easier on the eyes" than white paper. In adopting this paper we do not necessarily subscribe to the many weird ideas and associated claims regarding the superior qualities of colored papers since these are largely fanciful. From certain standpoints, however, especially when used under artificial light paper of a yellowish tint provides a slightly greater degree of esthetic comfort and if this desirable quality can be attained without material sacrifice in visibility the use of such a tinted paper seems justified. Insofar as we have been able to ascertain, the reflection factor of this tinted stock is approximately the same as for white paper and certainly it is quite easy to look at. Realizing that the practical man in the power plant often has to do his reading in places where the general illumination is not primarily designed for reading purposes we are adopting this paper for this section in the hope that it may contribute something to his comfort. If for no other reason it will serve to differentiate this section from the other parts of this paper. We will appreciate your comments on this.

CONTENTS

The Practical Engineer—Who Is He? 460

How Would You Do It? 461

Boilers, Fans and Pumps 462
- Horsepower Needed to Pump Water.
- Pipe Line Anchors.
- Feeding Chemicals Into Feed Line.
- Pump Speeds.
- Steam Pump Classifications.
- Soot Pockets.
- Fan Balancing Weights. By R. Boylan.
- Water Softeners.
- Water for an Industrial Power Plant.
- Versatile Belt Drive.

The Handy Line Current Calculator. By Vernon W. Palen 465

Compressed Air Pointers 466
- Water for Air Compressors.
- Compressed Air Horsepower.
- Starting Steam Compressors.
- Safety in Compressed Air Piping.

Laboratory and Shop 467
- Checking High Range Thermometers. By H. M. Naylor.
- Resistance of Rectangular Conductors. By C. G. Key.

Letters and Comments 468
- Orifices Reduce Heating Bill.
- License and Diesel Experience.
- Suggested Requirements for Engineers License.
- Lighted Steam Clouds Make Colorful Display.
- Brine Foaming.
- Pump Valve and Seat Refacer.

Engine Troubles—Indicated and Diagnosed. By Roy L. Brown 470

Shorts 471

Questions and Answers 472
- Parallel Operation of Generators.
- Finding the Quality of Exhaust Steam.
- Lifting Hot Water.
- Boiler Questions.
- Transformer Connections.
- Effect of Static Head on Gage Readings.

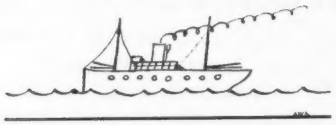
The Lifting Capacity of Tackle 474

A Section of Power Plant Engineering

TECHNICAL PUBLISHING COMPANY
53 WEST JACKSON BLVD., CHICAGO, ILL.

The Practical Engineer— WHO IS HE?

MANY YEARS AGO when the writer was engaged in the fanciful task of saving the world for democracy, it was his questionable privilege as an embryo naval officer to participate in taking some of the much publicized 90 day ships across the Atlantic on their maiden voyages. Naturally we carried on in the engine room and part of our duties on these first trips was to complete construction and incidentally adapt the equipment for operation. In the rush of putting these vessels together in the alloted 90 days, many things were left unfinished; steam and water lines were bare—they had to be covered—railings and walkways had to be put in place, wiring had to be run—no fooling there was plenty to do.

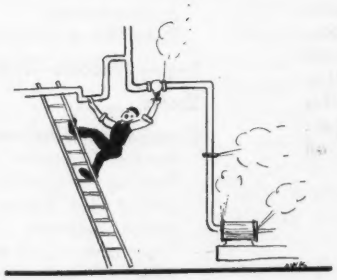


Our 90 day ships . . . 90 days to cross

Aside from the exhilaration of the work, it was on these vessels that we young squirts learned in the hard school of experience what engineering should not be. For, these ships, it appeared, had been designed and built by any but practical engineers. How did we know? It was only too obvious. No man who had ever had to manipulate a valve could possibly have installed valves in the incredible locations and positions we found them on these ships; indeed, often we never found them. To a draftsman, working in the comfortable seclusion of the drafting room a valve no doubt meant merely a symbol somewhere on an expanse of white paper, but to us in the engine room it meant something that could be reached without having to crawl down into the bilges or having to become a contortionist.

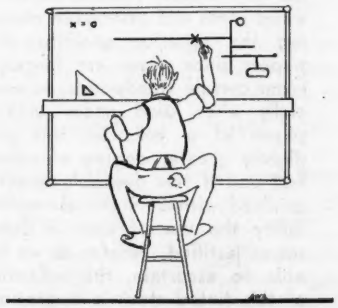
Our difficulties with the outlandish geography of the mechanical equipment on these ships served indelibly to impress on our minds the difference between "practical" and impractical engineering. The designers of these ships may have understood the theoretical elements of steam engineering, but it was overwhelmingly obvious that they had no knowledge of the practical side of engineering. Only an operator, who had repeatedly cursed the stupidity of some designer in placing a valve in a location where only a gymnast could reach it, really knows how and where a valve should be placed.

The point we are trying to make here is that the practical engineer's knowledge is born of practical experience in the field he serves. The practical engineer belongs to no particular class or rank; he may be the superintendent of a billion dollar utility system or he may be a fireman in a small heating plant; their realms of action may be at opposite poles, but the nature of their knowledge rests on the same foundation—experience, and that in a sense makes them brothers. What they know, they know because they have "done it," not because they have read it or because somebody told them. One can read about such a simple thing as cutting and fitting a gasket until he feels there is nothing more to be known about it, but until one has actually cut and put a gasket in place, he has much to learn about the process. The intangibles are never put in the book.



The incredible positions of the valves

This does not mean that the practical engineer is not susceptible to the ideas of others or that he cannot learn by reading, for if that were the case we might as well stop right here. The practical engineer assimilates knowledge as readily as anybody else but before he can accept a new idea he must project it against the background of his experience in order to evaluate its usefulness. He does this unconsciously, of course, but he does it, nevertheless, and that is why his apparently "snap judgment" often is more correct than the so-called reasoning of theorists. It was a theorist who proved by involved so-called scientific calculation or reasoning early in the 19th century that a steamship could never cross the Atlantic because it could never carry sufficient fuel for the voyage. It was a practical man, however, that brought the first steamship across almost before the theorist's prophecy appeared in print.



To a draftsman a valve is merely a symbol

In this new section which is being inaugurated this month we expect to deal largely with facts—facts that have been tried and proved by practical men in the field. It is a section where practical engineers will give and receive help in the practical operation and maintenance of equipment for both the generation and utilization of power. If you have any ideas which you have put into practice and found useful, send them in;, they may help some other fellow and his methods in turn may be of value and assistance to you.

EXTRA! EXTRA!

Announcing a brand new contest with prizes an' everything for the best answers to a practical problem. Fifteen dollars in cash given away each month and another prize of a set of books for your ideas. Don't miss this opportunity.

How Would You Do It?

WE HAVE ALL heard of the marine engineer who repaired a cracked cylinder head at sea with a section of steel floor plate. Whether this ever actually happened or not, does not matter, the story typifies the resourcefulness of the operating engineer —not only the marine engineer but the stationary plant engineer as well. For though the stationary plant engineer may be closer to sources of supply than his sea-going colleague, his problems are the same and he is often called upon to make emergency repairs that cannot wait for proper replacement parts. The practical engineer is a resourceful cuss by very nature; he delights in working out his own solutions to problems that come his way. One cannot visit very many plants without finding ample evidence of his ingenuity. It may be only a gadget for removing the pointer from a steam gage or it may involve the arrangement of his entire plant or the manner in which it is operated, but whatever it is, it reflects the engineer's ingenuity. No two engineers will solve a problem in exactly the same way.

Unfortunately many of these ingenious ideas never get beyond the plant in which they have their birth. It is not that the engineer is secretive, indeed he is quite the opposite and as a rule is only too happy to give someone else the benefit of his experience, but by virtue of the nature of his job he keeps close to his plant and it is only rarely that his ideas get into general circulation.

It is this state of affairs that prompts us, this month, to put into effect a plan which we have long had under consideration and which we hope will result in a more fruitful interchange of ideas, at the same time making these pages more useful to the practical engineer in the plant.

Beginning with this issue we will provide a monthly contest in which a prize is offered to the persons sending in the best solutions to a specific problem, a new problem being presented by us each month. This problem will involve some phase of power plant operation or design such as might be encountered in any plant and capable of solution in a variety of ways. Whether or not the problem has come up in the experience of the contestant does not matter, he is privileged to use his imagination and ingenuity in any way he sees fit.

As in all contests, it has been necessary to lay down a few rules, but these are very simple and involve few restrictions. Here they are:

1. Solutions must be mailed to reach the editorial offices of Power Plant Engineering before the 25th of the publication month of the issue in which the problem appears. (For example, the solutions of the problem presented in this, the July issue, must arrive before July 25. They must be addressed to the Contest Editor, Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

2. Manuscripts must not be longer than 1000 words, written in ink or typewritten with double spacing and written on one side of the sheet. Diagrams and sketches may be in pencil but they must be neat and clear.

3. All solutions become the property of POWER PLANT ENGINEERING subject to publication in the magazine. All material used will be paid for.

4. The editors of POWER PLANT ENGINEERING will serve as judges. Their decisions will be final. Duplicate prizes will be awarded in case of ties.

5. Two prizes will be offered each month, the first a cash prize of $15.00 for the best solution of the problem, and a second prize of a set of five power plant handbooks, for the second best solution.

The purpose of this contest is to

PROBLEM No. 1

In introducing the hero of this department we find him puzzled as a result of a talk with the superintendent of the mill to which his power plant furnishes steam and electric power. The plant has a 1500 kw. extraction turbine, bleeding steam for process work at 20 lb. pressure. The extraction line is fitted with a 14 in. multiport non-return valve having 5 lb. springs. These springs maintain a 5 lb. differential pressure, that is, when there is 25 lb. pressure on the turbine side of the non-return valve, the pressure on the extraction line side is 20 lb.

In the conversation that has just taken place the mill superintendent has indicated the desirability of raising the extraction pressure to around 23 lb., pointing out that the process would thereby be improved.

Under present conditions, however, the turbine is operating at the limit of its capacity. So the engineer has been wondering whether he could replace the 5 lb. springs in the non-return valve by say 2 lb. springs. This, he reasons, would raise the pressure in the extraction line to 23 lb. but he wonders whether this would not reduce the amount of steam extracted.

stimulate interest in the practical side of power plant engineering and to promote the interchange of ideas among engineers. Frankly, it is somewhat in the nature of an experiment and its success depends entirely upon the support you give it by contributing your ideas. Do not hesitate to submit your ideas—remember, this is a contest for practical engineers and your solution will have just as much weight as the next fellow's.

Go to it; let's see how ingenious you are.

BOILERS, FANS and PUMPS

Horsepower Needed to Pump Water

Often it is desirable to calculate the horsepower required to pump a given amount of water against a given head. Sometimes the necessary information can be obtained from charts or tables although the formula is so simple that it can be used almost as quickly.

Water is commonly measured in gallons per minute and the head in a gallon of water weighs 8⅓ lb., therefore 8.3 × g.p.m. × head in feet equals the theoretical foot pounds of work required per minute to pump the water. The pump is not 100 per cent efficient, however, so that the work required from the prime mover will be theoretical foot pounds divided by the efficiency. Then, 33,000 ft. lb. of work per minute is equal to one horsepower so that the total horsepower required will be the actual foot pounds of work divided by 33,000. Dividing out the constants the formula becomes in round figures

$$Hp = \frac{\text{G.p.m.} \times \text{head in feet}}{40 \times \text{efficiency in per cent}}$$

The head used must be the total static head from the suction level to the discharge level plus the pipe friction. This can most conveniently be found from pressure gages on the pump discharge and suction. If the water flows to the pump under pressure the suction gage reading should be subtracted from the discharge gage pressure to give the net head. If the suction level is below the pump so that the suction gage reads a vacuum the readings of the two gages should be added. It is well to correct all measurements to the center line of the pump.

Water is commonly measured in gallons per minute and the head in feet of water. In cases where the pump discharge pressure is given in pounds per square inch, the head in feet can be obtained by multiplping the pressure in pounds per square inch by 2.31. A column of water 2.31 ft. high is equivalent to a pressure of 1 lb. per sq. in. Similarly when the suction or vacuum is measured in inches of mercury it may be converted into feet of water by multiplying by 1.13 for 1 in. of mercury equals 1.13 ft. of water.

As an example assume 100 g.p.m.: a total head of 75 feet and a pump efficiency of 60 per cent. The horsepower requirement is therefore

$$\frac{100 \times 75}{40 \times 60} = 3.12 \text{ hp.}$$

If then the efficiency of the driving motor was 75 per cent the input to the motor would have to be 3.12 divided by 75 per cent or 4.16 hp. Inasmuch as 1 hp. is equal to 0.746 kw., 4.16 is equal to an electrical input of 4.16 × 0.746 or 3.1 kw.

Pipe Line Anchors

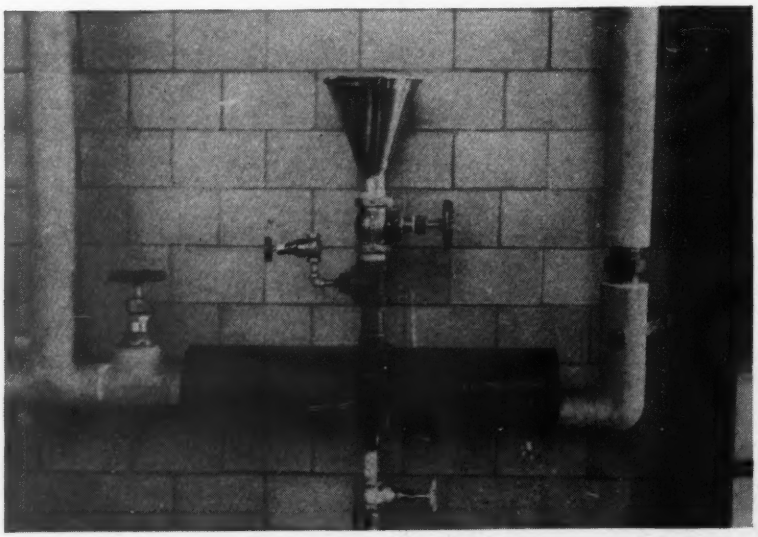
Before the widespread use of welding for steam and water lines in the power plant, a great deal of detailed work was necessary in the shop and on the drafting board. Since welding has been introduced, a great deal of this work is now being done in the field and because of the comparative ease of making odd shapes, many things can be accomplished which could not be done a few years ago. The attached photograph shows a welded-end type elbow with a special anchor attached to the side wall of a tunnel. This is a 14 in., 400 lb., 750 deg. F. steam line installed in Building 265 of the G. E. Schenectady Works.

400 lb. steam line anchored to the side wall of a tunnel

Feeding Chemicals into Boiler Feed Line

At the plant of O. P. Hood and Sons, at Charlestown, Mass., the homemade chemical feeder shown in the accompanying illustrations has given excellent results. It consists merely of an enlarged section in the main feed line made of a short length of steel pipe about 8 in. in diameter with plugs welded in the ends. These ends are drilled and the feed line welded in place. At the top a funnel is arranged with a valve as shown. In this case tri-sodium phosphate is the chemical used.

In use, the two valves in the feed line are first closed. Then the other two valves are opened and the water in the enlarged section permitted to drain out. The drain valve is then closed and the charge of tri-sodium phosphate introduced in the funnel. When it has entered the enlarged section the valve in the funnel is closed and the two valves in the feed line opened.



Chemical feeding device for boiler

Pump Speeds

In order to obtain the most satisfactory operation from a pump and to prolong the useful life of the moving parts, it is recommended by the Hydraulic Society that the piston or plunger speeds as shown by the accompanying curves be considered as the maximum for continuous operation.

Inasmuch as each piston makes two complete strokes for each revolution, the number of revolutions per minute can be calculated for any stroke by multiplying the piston speed in feet per minute by 6 and dividing by the length of the stroke in inches. Thus a 12 in. stroke pump in general service has a recommended piston speed of 60 ft. per minute and 60x6/12 is 30 r.p.m.

Steam Pump Classifications

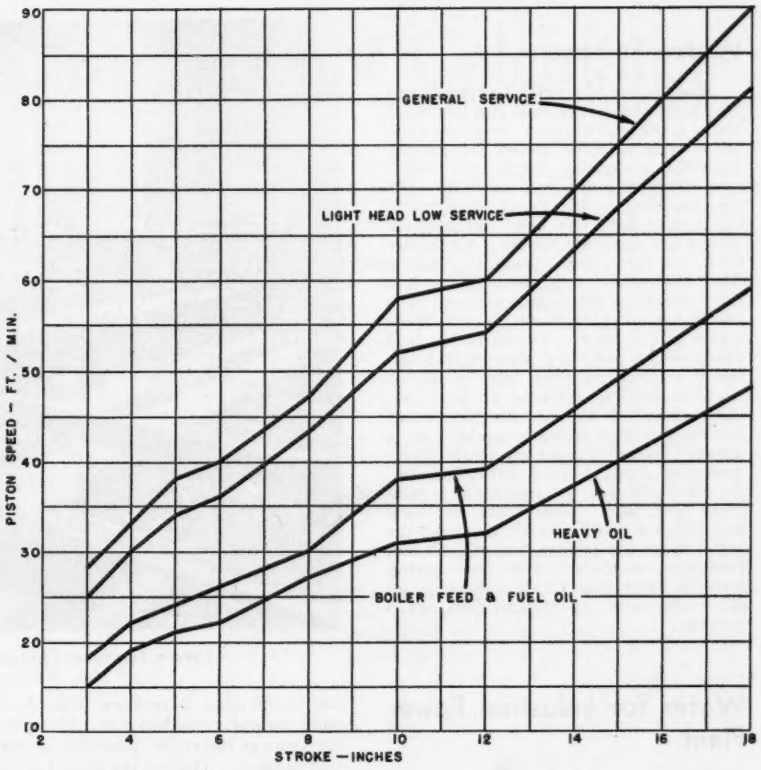
Reciprocating steam pumps are made up with a variety of bronze, iron and steel parts to meet specific conditions. Standard bronze, and full bronze fitted are normally considered by members of the Hydraulic Society as standard for steam driven displacement pumps. In addition to these a number of other types known as acid resisting, all bronze and all iron are recognized as special. Details of these various fittings are as follows:

Standard Fitted (Symbol S.F.). Steel piston rods, iron liquid pistons or plungers, bronze or rubber liquid valves, bronze liquid valve seats, guards and springs, liquid cylinders iron or steel. Piston pattern pumps have bronze lined liquid cylinders. Plunger pattern pumps, iron cylinders and plunger glands, not bushed, steel cylinders, and plunger glands, bronze bushed.

Bronze Fitted (Symbol B.F). Bronze piston rods (except end packed plunger pattern) iron liquid pistons or plungers, bronze or rubber liquid valves, bronze liquid valve seats, guards and springs, liquid cylinders iron or steel; piston pattern pumps have bronze lined liquid cylinders, plunger pattern pumps have bronze bushed plnnger glands and throats.

Full Bronze Fitted (Symbol F.B.F.). Bronze piston rods (except end packed plunger pattern) bronze liquid pistons or plungers, bronze or rubber liquid valves, bronze liquid valve seats, guards and springs. Liquid cylinders iron or steel. Piston pattern pumps have bronze lined liquid cylinders, plunger pattern pumps have bronze bushed plunger glands and throats.

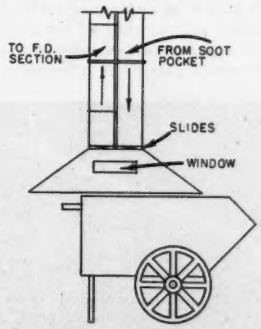
Acid Resisting Pump (Symbol A.R.). All parts of the pump in direct contact with the liquid pumped are constructed of such materials as will offer the maximum resistance to the corrosive action of the liquid. All Bronze Pump (Symbol A.B.). All parts of the pump coming in direct contact with the liquid pumped are of bronze. All Iron Pump (Symbol A.I.). All parts of the pump coming in direct contact with the liquid pumped are to be made of iron or ferrous metal.



Piston or plunger speed in feet per minute as recommended for direct acting steam pumps by the Hydraulic Society. Power pump speeds may be increased 30 per cent over the above figures

Soot Pockets

In order to eliminate as much of the fly ash and cinders as possible from the flue gas before it reaches the stack, it is common to install soot hoppers or pockets at various points in the boiler and induced draft fan system. In the Mac Sim Bar Paper Co., described on page 781 of the December, 1938, issue, a pocket of this kind is installed between the economizer and the induced draft fan. This pocket is emptied by the arrangement shown in the sketch. The drop leg from the pocket extends down under a hood built just high enough to accommodate a two wheel buggy. A riser on the left goes back to the induced draft fan suction. When the gates in these two legs are withdrawn the soot blows out into the buggy and the dust is sucked back into the fan suction without spreading through the basement. From the window in the hood the operator can tell when the pocket is empty.

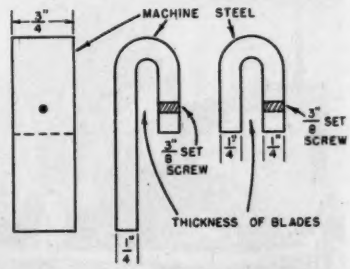


A return line makes it possible to empty soot pockets without dust.

Fan Balancing Weights

By R. Boylan

After induced draft fans have been in service for some time they are likely to be eroded in places and when repaired by welding or other means they become unbalanced to an extent that excessive vibration takes place. To devised a set of steel weights which I use until I get a balance when the regular weights are fastened permanently to the side of the fan.



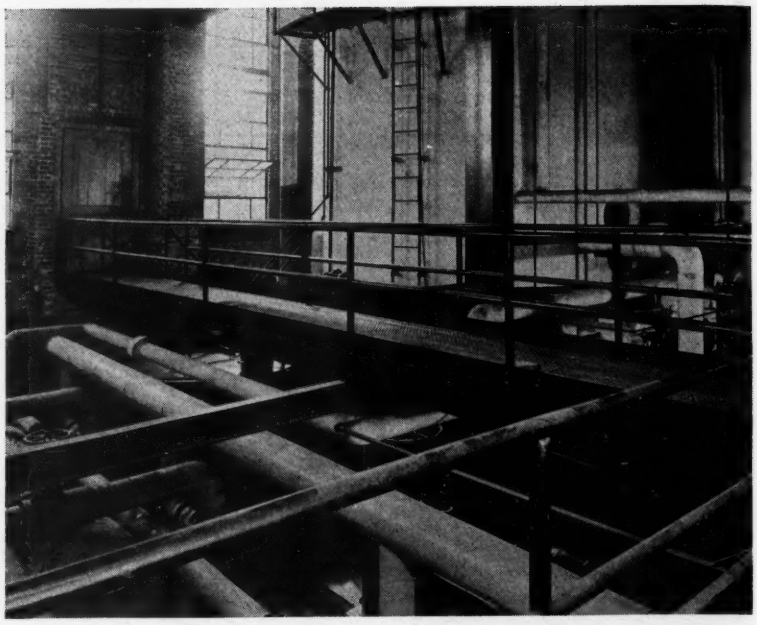
Steel shapes used to balance induced draft fans

bring the fans back into balance, I have

These pieces are marked to indicate their weight in ounces, thus: 4, 5, 5½, 6, etc.

Water Softener

MAKING use of a method of deaeration in which the preheated and softened water is atomized into a very fine mist by a high velocity steam jet issuing from the atomizing nozzle, the Cochrane deaerating hot process water softener installed by the Produce Terminal Corp., Chicago, has been designed to soften and deaerate 32,000 g.p.h. boiler feed for their high pressure boilers. The chemical treatment comprises lime and soda ash, supplemented by a treatment of phosphate to the feedwater at the suction of the boiler feed pump. The auxiliary phosphate treatment insures freedom from scale on the evaporating surfaces at low concentrations of alkali. As the water leaves the deaerating chamber, it is passed through filters containing calcity where the finely divided suspended matter is removed, producing a crystal clear feedwater. The filters are back washed periodically by withdrawing the water from the sedimentation tank and returning it thereto and thus saving heat in water that would otherwise go to waste with an independent wash system.



Water Treatment Equipment at the Chicago Terminal Corp.

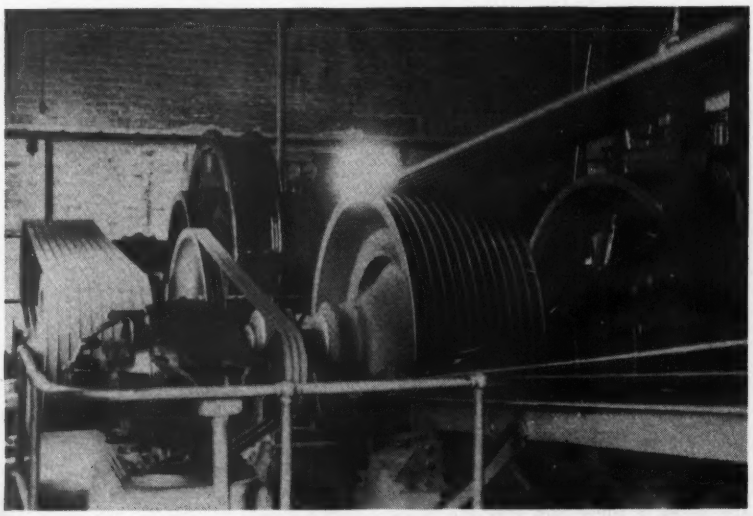
Water for Industrial Power Plant

The problems of water for steam generation are becoming increasingly difficult because of the rapid trend to higher pressures, and the extremely hard service to which tubes are being subjected in water-cooled furnace walls and screens. The changed operating conditions demand, not limitation, but absolute absence of scale, since uncertain outages of larger units cannot be tolerated. Lime-soda and zeolite processes of softening water will remove a large proportion of the scale forming constituents in the natural water.

Use of evaporated water and condensate greatly relieves this trouble, and continuous blowdown should receive careful consideration. However, the average industrial plant has a very high makeup. During the period of the year when there is no heating load, the condensate return may be as as low as ten or fifteen per cent. Some of the returns may come from processes which are highly contaminated with oil or organic materials which must be removed.

A note of caution regarding the return of condensate, however, is that steam from certain chemical processes either should not be used or should be carefully watched to see that there are no chemicals getting into the returns through leaky coils or heat exchangers which might be damaging to the boiler. The same also applies to heat exchangers for heating oils or paints.

No small plant has a technical staff capable of the most accurate water supervision; and where water conditions are bad, it may be well to use the service of some of the laboratories that specialize in this work.—From a paper by F. Elwell before the Midwest Power Conference.



Three different drives from a single engine

The Versatile V-Belt

PROBABLY no single drive is more widely used than the multiple V-belt drive which provides quiet, efficient and compact service. The accompanying photograph shows a Diesel engine, in a Minnesota rolling mill, driving from three separate V-belt drives, the main line shaft to the mill, an exciter and a generator.

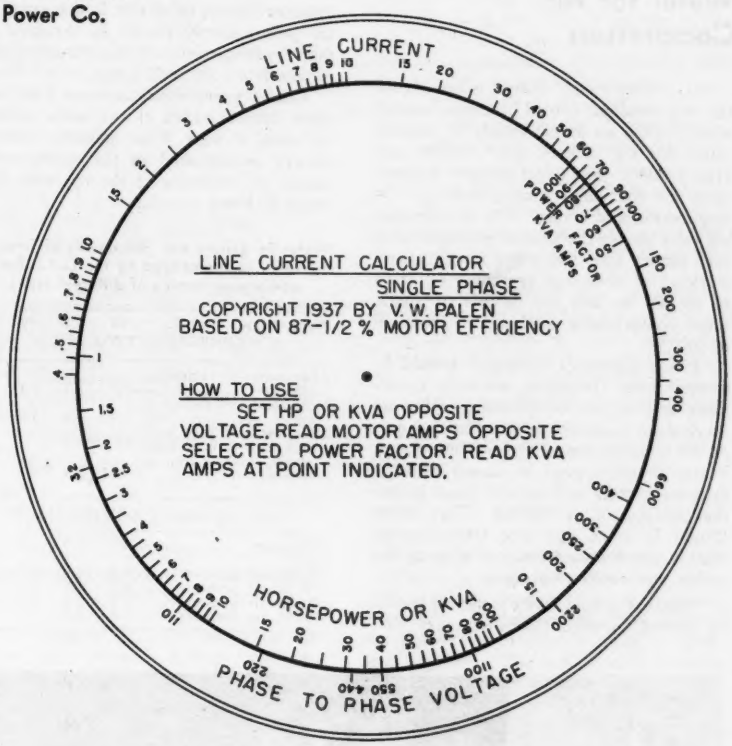
V-belts often appear loose on the flat side due to slight irregularity in the length of the different belts. When running loaded, however, they equalize on the tight side. These belts are rubber and require no dressing. They should be figured with a liberal factor of safety so that the breakage of one belt does not cause a shut down.

The drive base arrangement should be such that it can be shortened when a new belt is put on so that the belt can be placed in the grooves without forcing. The adjustment should then be tightened until the belts are fairly snug.

When they are operating at full load and full speed adjustment should be made and the take-up shortened until only a slight bow appears on the slack side. The exact amount is a matter of experience and to a certain extent depends upon the type of drive. Vertical belts and short center drives, especially with pulsating loads, need to be tighter than horizontal drives with reasonably long centers.

The Handy Line Current Calculator

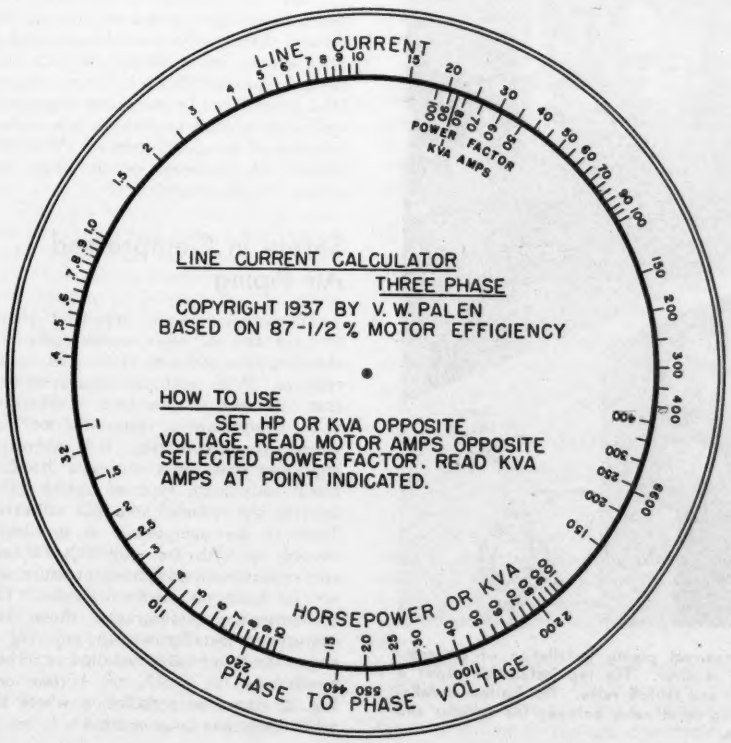
By VERNON W. PALEN
Northern States Power Co.


LINE CURRENT
POWER FACTOR
KVA AMPS
LINE CURRENT CALCULATOR
SINGLE PHASE
COPYRIGHT 1937 BY V. W. PALEN
BASED ON 87-1/2 % MOTOR EFFICIENCY
HOW TO USE
SET HP OR KVA OPPOSITE VOLTAGE. READ MOTOR AMPS OPPOSITE SELECTED POWER FACTOR. READ KVA AMPS AT POINT INDICATED.
HORSEPOWER OR KVA
PHASE TO PHASE VOLTAGE

THE LINE CURRENT calculator shown in the accompanying illustration will be found very useful in determining the capacity of conductors and cables around the plant. By cutting out the inner circles in each case, mounting both parts on a thin sheet of cardboard and then fastening them together at the center so that the smaller circle turns on the larger one, a circular slide rule is obtained. If desired, the two charts so obtained may be mounted back to back.

One side, as indicated, gives values for single phase circuits; the other for three phase circuits. By merely setting the value of the horsepower or kv-a. of the load opposite the phase, its phase voltage on the outside scale, the amperes can be read opposite the known power factor of the circuit. For example, with the chart set as shown in the drawing for the single phase condition, for a 40 hp. load and a circuit of 550 v. a line current of 75 amp. is indicated when the power factor is 80 per cent. If the load is expressed in terms of kv-a., for the same values of load and voltage, the line current (opposite "kv-a. amp.") is found to be a trifle over 70 amp.

For a three phase circuit the procedure is exactly the same except that the three phase side of the chart must be used.


LINE CURRENT
POWER FACTOR
KVA AMPS
LINE CURRENT CALCULATOR
THREE PHASE
COPYRIGHT 1937 BY V. W. PALEN
BASED ON 87-1/2 % MOTOR EFFICIENCY
HOW TO USE
SET HP OR KVA OPPOSITE VOLTAGE. READ MOTOR AMPS OPPOSITE SELECTED POWER FACTOR. READ KVA AMPS AT POINT INDICATED.
HORSEPOWER OR KVA
PHASE TO PHASE VOLTAGE

Compressed Air Pointers

Water for Air Compressors

ALL TYPES of air compressors, except the very small air cooled or hopper cooled sizes, require an ample supply of cooling water for the jackets, inter coolers and after coolers. The exact amount depends upon the particular arrangement of the compressor and cooler. The accompanying table shows the amount recommended for single and two-stage compressors working at discharge pressures of from 80 to 100 lb. and for jackets of single stage compressors working at from 40 to 100 lb.

These quantities of water should be ample, under ordinary working conditions, to bring the temperature of the air leaving the coolers to within about 20 deg. of the temperature of the entering water. Water should always be turned onto the cylinder jackets and cylinder head before the compressor is started. This water should be clean and free from foreign matter which would scale or clog up the jacket and cooling passages.

When very cold water is used it should be passed through the intercooler first in order to avoid condensation in the cylinder jacket, or if this is not possible, the jacket supply should be throttled so that the temperature of the leaving water ranges from 100 to 115 deg.

Outlet water should always flow into open funnels. If a closed water system is used, a pipe flow indicator should always be included in the piping as a means of indicating to the operator that water is being circulated.

Water in gallons per 100 cu. ft. of free air delivered recommended by the C.A.I. for air compressor service of different types

Water temp., Deg. F.	60	70	80	90
COMPRESSION TWO STAGE				
Aftercooler or intercooler separate	1.0	1.2	1.4	1.6
Intercooler and jackets in series	1.4	1.6	1.9	2.1
Both low and high pressure jackets with water supply separate from intercooler	0.85	1.0	1.2	1.4
SINGLE STAGE COMPRESSION				
Aftercooler	1.0	1.2	1.4	1.6
Jacket				
40 lb. air pressure	0.5	0.6	0.7	0.9
60 lb. air pressure	0.6	0.7	0.8	1.0
80 lb. air pressure	0.7	0.8	0.9	1.1
100 lb. air pressure	0.8	0.9	1.0	1.2

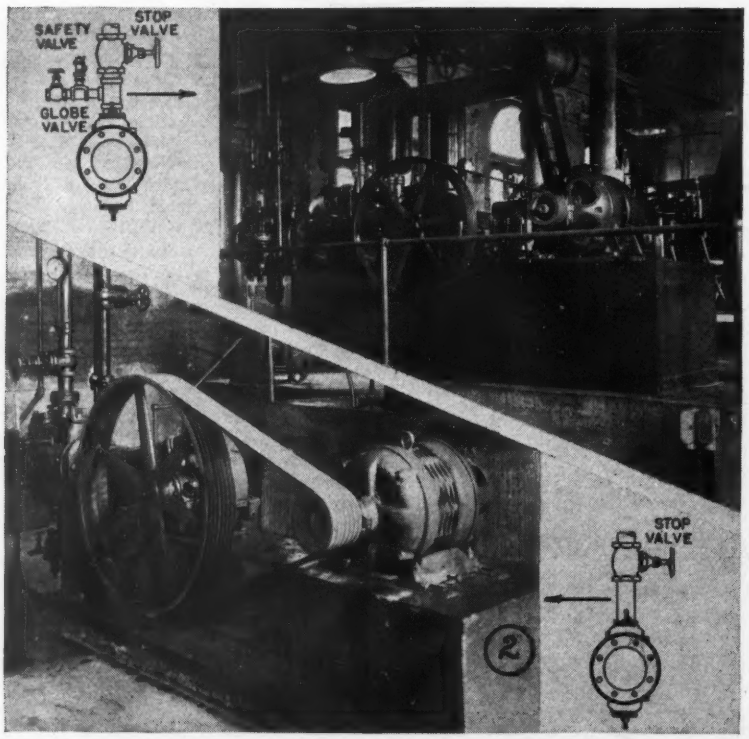


Fig. 1 (Top). Correct and Fig. 2 (Bottom) incorrect piping installation of air compressors discharging to a common intercooler or receiver. The top installation shows a relief valve properly installed between the cylinder and shutoff valve. The bottom installation shows the wrong method of installation with no relief valve between the cylinder and shutoff valve

Compressed Air Horsepower

POWER REQUIRED to compress air depends upon the method of compression, the altitude at which the compressor is located and the discharge pressure against which the machine operates. At sea level single stage compression to 100 lb. requires theoretically 18.1 hp. per 100 cu. ft. of free air per minute. Two stage adiabatic compression reduces this to 15.4 hp. due to the cooling effect of the intercooler between stages. With true isothermal compression this figure is further reduced to 13.2 hp. for either single and two stage compression. Actual compressors of the two stage type with jacket cooling will come somewhere between these last two figures.

At an altitude of 5000 ft., the isothermal horsepower increases from 13.2 to 11.8 hp. and at 10,000 ft. elevation the power requirement is further reduced to 6.4 hp. Corresponding figures for two stage adiabatec compression is 13.9 and 12.6 hp.

Starting Steam Compressors

BEFORE a steam driven reciprocating compressor is started, the drain cocks on the steam cylinders and the drain of the steam pipe above the throttle valve should be opened. After this is done the throttle should be cracked slightly and a small volume of steam allowed to flow into the cylinder, and through the bypass into the receiver of compound engines in order to warm up all parts.

After the cylinders, receivers and connecting pipes have been thoroughly heated, the throttle should be opened a little more, just sufficient to turn the compressor over slowly. The speed and load should then be increased very gradually, taking care to observe that undue heating of no part occurs. After all danger of condensation is past, the drains can be closed.

Safety in Compressed Air Piping

IT IS common in industrial plants to have two or more compressors discharging to a common aftercooler or air receiver. With such an arrangement a shut off valve of some kind is necessary at the compressor to isolate the machine when it is not operating. It is extremely important that the compressor itself is fitted with some type of safety valve between the cylinder and shut off valve. Then if the compressor is accidently started up with the stop valve closed, an excessive and dangerous pressure will not be built up in the cylinder. The accompanying photographs show two compressor installations—the top, Fig. 1, shows the relief valve installed as recommended by the C.A.I., the bottom one, Fig. 2, shows an installation where the relief valve has been omitted.

Laboratory and Shop

Checking High Range Thermometers

By H. M. Naylor

HAVING a situation with a large turbine where it is imperative to sharply define the upper limit of steam temperature at the throttle we found it necessary frequently to check the accuracy of both recording and indicating thermometers not only on the turbine but on each of several boilers.

In order to expedite these checks we devised a piece of laboratory apparatus that has proven quite satisfactory. The expense was quite negligible compared to the service it has rendered, since most of the materials came from the scrap pile.

A 24-in. length of 4-in. pipe was fitted with a welded flange on each end. To each of these were attached a pair of legs or feet to support the apparatus in a horizontal position, with the bottom about 6 in. above the table.

Each end was closed with a bolted-on blind flange using a soft copper gasket. The center of each blind flange was drilled and tapped to receive a standard 12-in. thermometer well. These wells are a permanent part of the apparatus.

A 2-in. length of ½-in. pipe was welded to the reservoir in a vertical position for the double purpose of venting and inserting the laboratory standard thermometer.

Three 20-in., 500 watt strip heaters were clamped to the reservoir; one on the bottom and one on each side at the ends of the horizontal diameter.

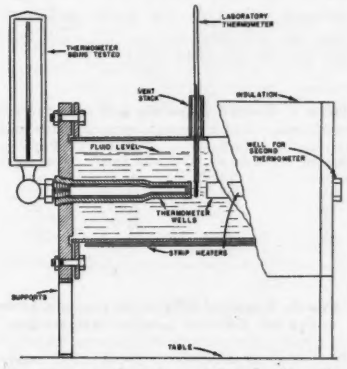
The entire reservoir, except the ends was then covered with 2 in. of high temperature insulation.

Current supplied to the heaters is controlled by means of a simple rheostat, permitting holding the temperature of the bath at a predetermined point.

The bath solution used was a commercial product sold under a well known trade name. This substance is a hard crystalline salt at atmospheric temperatures, melting at 273 deg. F. and boiling at 1410 deg. F. Repeated meltings and hardenings do not affect it and loss by evaporation is slight. The thermal expansion is quite marked being roughly 15 to 20 per cent. Care must be used not to fill the bath too full.

To use the bath, simply remove the thermometer to be tested from its well and insert it into one of the wells on the bath. Set the rheostat to hold the temperature at which you wish to check. The actual temperature of the bath is determined by the laboratory thermometer inserted through the vent stack.

Since the laboratory thermometer has its bare bulb immersed directly in the liquid its response to changes in temperature will be immediate, whereas there will be more or less time lag in the response of the thermometer being checked due to the insulating effect of the well. Ample time must consequently be allowed to be sure that both thermometers have reached a state of equilibrium. This is especially true if the bulb stem on the thermometer being tested is shorter than the well. On the other hand, if the bulb stem is longer than the well, the thermometer will probably read a little low due to the partly exposed stem.



Arrangement of equipment for checking thermometers

The second well on the other end of the bath permits testing two thermometers at once.

Always remove the laboratory standard thermometer from the vent before the bath liquid freezes. In case this is accidentally allowed to happen, it will be necessary to re-melt the bath before the thermometer can be removed.

Admittedly, results are not of a high order of accuracy, yet thermometers can be checked within at least plus or minus one degree, which is entirely satisfactory for our purposes. The addition of thermostatic control would be the only further requirement to permit precise work.

Resistance of Rectangular Conductors

By Eugene George Key

THE FORMULA for finding the resistance of circular electrical conductors is well known:

$$R = p \frac{l}{A}$$

where R is the resistance, p the resistance per circular mil foot, A the area in circular mils and l the length in feet. However, the transition from this formula into one for determining the resistance of a rectangular conductor appears to be a regular bugaboo, especially to students in Electrical Engineering in colleges.

Although I have studied resistance calculations in books and in practice for some time, I have not seen a simplified formula similar to the one for circular wire. I think such a formula would be obvious. Yet the one taught in schools and in books is:

$$R = p \frac{l}{1{,}275{,}000\ A}$$

where R is the resistance, p the resistance per circular mil foot, l is the length in feet, A is the area in square inches and 1,275,000 is the number of circular mils in a square inch. The difficulty with this formula should be apparent:

1. It presents another figure for the student or engineer to memorize in addition to all the other memory work required in the course.
2. The figure 1,275,000, although accurate enough for all practical measurements, is not the real value. The correct figure is 1,273,235 plus a fraction.
3. It presents a new formula to memorize, which is apt to confuse the beginner, at least, in his use of the formula for round conductors. The A in the first formula is in circular mils, that of the second, in square inches.

The formula which I suggest is the following:

$$R = p \frac{(0.7854)\ l}{A}$$

where R is the total resistance, p the resistance per mil foot of circular wire, l the length in feet, A the area in square mils, and .7854 the value of pi over 4, the conversion factor between a circle and a square. The use of this formula is illustrated by the following problem:

Find the resistance of a bar 24 ft. long with a cross-section of ½ by ¼ in., if the bar is made of annealed copper of p equal to 10.4.

The formula becomes:

$$R = \frac{10.4 \times 0.7854 \times 24}{250 \times 500}$$

$$= \frac{10.4 \times 0.7854 \times 24}{125{,}000} = 0.001568 \text{ ohms}$$

By the other formula, this becomes:

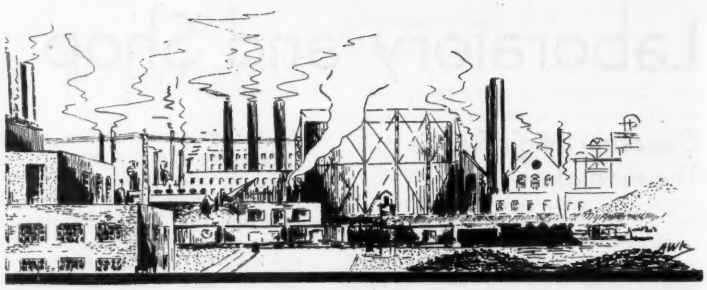
$$R = \frac{10.4 \times 24}{1{,}275{,}000 \times \frac{1}{2} \times \frac{1}{4}}$$

$$= \frac{10.4 \times 24 \times 8}{1{,}275{,}000} = 0.001566 \text{ ohms}$$

The advantages of my formula are also apparent:

1. No new number need be memorized—.7854 is a common number in many calculations in electricity and mechanics. It is even marked on the A and B scales on the slide rule, making calculations by that instrument much simpler.
2. The areas used in both the circular and rectangular formulae are thus alike—the horizontal dimension in mils multiplied by the vertical dimensions in mils apply to both.
3. It is accurate, not only for all practical purposes, but for all purposes, practical or otherwise.

LETTERS AND COMMENTS



Orifices Reduce Heating Bill

A 48 STORY office building, opened for business in 1931, equipped with 1800 radiators, having 67,000 sq. ft. of radiation, was difficult to heat from the tenth story down. As the owners refused to spend any money on the heating system, in the winter 1937-38, we installed our own orifices, as shown in Fig. 1, a

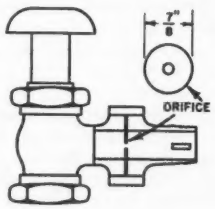


Fig. 1. Location of orifice in radiator valve

No. 19 copper disk in the union of the radiator valve, holes for the different size radiators being given in Table I. The cost was less than $20.

The building was not only more comfortable owing to better distribution, but the cost of heating the building was $3000 less than the average for the previous 5 yr. We also installed a mercury gage across the last radiator on the line, and kept the differential pressure, for the different outside tempereatures as shown in Table II.

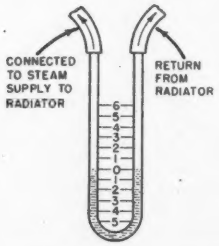


Fig. 2. Mercury gage connected across radiator

The holes in orifices, Table I, will fill the radiators with steam at atmospheric pressure. We buy our steam from a central station plant on a sliding scale, it averages 95 cents a thousand pounds, comes into the building at 150 lb. pressure, to a primary reducing valve that is pilot operated, so we can get the desired pressure, which depends on the outside temperature. Also, secondary reducing valves of the weigh and lever type are installed, one on the 17th floor and one on the 29th floor.

Table I. Orifice diameter and radiator size

Orifice dia. in.	Radiator area sq. ft.	Orifice dia. in.	Radiator area sq. ft.
	18		61
	24		70
	30		80
	37		91
	44		102
	52		

Table II. Required differential pressure across orifice for different outdoor temperatures

Outdoor tem.	Pressure Differential (in Hg)	Outdoor tem.	Pressure Differential (in Hg)
0°	6″	40°	1.2″
10°	4.5″	50°	0.5″
20°	3.2″	60°	0.1″
30°	2.1″		

Last fall we installed thermostats and small motors, as shown in Fig. 3. The motors are heavy duty, known as damper motors, and revolve the levers 180 deg. to a stop. Closing the reducing valve

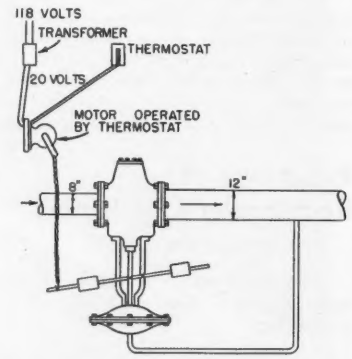


Fig. 3. Secondary reducing valve operated by thermostat through motor

when the temperature is high enough, then, when the temperature reduces, the thermostat breaks the contact, and gravity brings the reducing valve to the open position. This stops overheating in fine weather and after office hours. This year up to Feb. 15, 1939, the steam bill is $1000 less, on a degree day basis, than last year for the same period, with the orifices only.

Nutley, N. J. THOMAS SHEEHAN.

License and Diesel Experience

MUCH HAS BEEN said concerning the need for adequate license laws for steam engineers, but nothing has been said concerning license laws for Diesel engineers.

Most power plant Diesels require as much skill in operating and starting as steam engines for the dangers resulting from unskilled operation are equally grave. Many states require licenses for steam engineers but as far as I know no state requires a license for Diesel engineers. Such laxity and disinterest on the part of the state results in not only loss of respect for men engaged in that type of work, but it allows men not fitted or trained for that work to supplant trained men.

In one case a Diesel was operated for a considerable length of time with a cooling water temperature of 200 deg. F. To make matters worse the cooling water was not conditioned. The result was that a thick scale built up in the water jacket.

The condition was further aggravated by maintaining a high cooling water temperature which broke down the lube oil film on the cylinder walls causing stuck pistons, scored liners and other troubles.

Finally a lubrication engineer visited the plant and had a hard time trying to convince the operator that all the trouble was caused by the cooling water. No doubt there are many cases where Diesels are mishandled due to ignorance of the operator.

TARQUIN DE ROSA

So. Vineland, N. J.

Suggested Requirements for Engineer's License

NO MAN should be entitled to an operating engineer's certificate who has not successfully:

Scraped and turbined the inside of a boiler.

Cleaned out and repaired furnace settings.

Tested boiler for defects.

Burned coal or oil efficiently.

Ground valves and made pipe work repairs.

Mixed concrete, compound, paint.

Repaired asbestos covering.

Changed flange gaskets on all sizes of pipes.

Put new tubes in boiler.

Cleaned out oil filters.

Fixed damper controls inside and outside of breeching.

Repaired windows, toggles, switches, fuses.

Filed and scraped a bearing.

Set valves on an engine.

Shined brass.

Changed packing in pumps.

Taken indicator cards.

Figured horsepower of pump, boiler, engine.

Blown a generator out with air.

Started up a plant by himself with assistance of firemen.

Kept records of steam, coal, oil, ashes, compound, electrical output, and other things pertaining to plant practice.

Taken boiler water analysis.

Inspected his tank (oil) for sludge.

Figured capacity of a straight or tapered tank, or chimney.

Come up to the boiler inspector's wishes as to checking up on cooperating with him.

Cleaned engine and boiler room completely.

Checked sprinkler systems, fire pumps and apparatus.

Inspected motors, wiring, etc.

Painted walls and ceilings.

The explanation for the above is that every engineer should have a background of honest experience.

Fairview, N. J. N. G. MARTIN.

Lighted Steam Clouds Make Colorful Display

DURING a festival celebrating the opening of a recently completed manufacturing plant, a combination of steam clouds and vari-colored flood lighting was used to put on an exceptionally beautiful and effective nightly show. This method of advertising, suggested by the floodlighted fountains frequently found adorning parks and other publicly and privately owned areas, makes an especially colorful display. The shimmering iridescence of lighted droplets of water in the rolling masses of vapor emitted by strategically placed steam jets have all the rainbow like effects of lighted fountain sprays and because the lighting pattern changes with every air movement are even more striking.

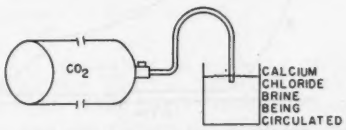
Although steam, because of its greater cost, can not economically compete with water in permanent display attractions of this type, it has a number of advantages that tend to offset this cost when adapted to the creation of temporary lighting effects. Among the most important of these are the simplified piping required and the fact that where available, it can be used at any point on the exterior of a building since no special drainage facilities are needed.

Low pressure wet steam is of course preferable to high pressure steam for this application because of its greater moisture content and less noisy discharge. Where high pressure steam must be used, a reducing valve should be installed in the supply line to the jets followed by a valved water connection to enable the injection of the proper quantity of water needed to give the correct moisture content in the discharged vapor. Jets are short pieces of pipe, equipped with valves, screwed into tees in the low pressure header and are sized according to the pressure and volume of steam needed to produce the cloud mass desired. A typical layout used to produce and illuminate a pyramidal shaped vapor mass during the celebration mentioned in the first paragraph of this discussion is shown in the drawing.

Roanoke, Va. S. H. COLEMAN.

Brine Foaming

QUITE some time ago a reader requested information on the prevention of brine foaming. I have found that with calcium chloride brine, adding CO^2 gas effectively prevents this foaming. Place a hose below the level



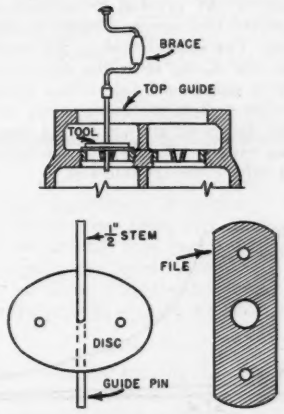
Adding CO_2 stops foaming brine

about 6 in. from bottom with just sufficient gas pressure so that it can be held with the thumb. We have about 300 cu. ft. of brine and circulate it for ½ hr. with the gas on, then another ½ hr. with the gas off. Foam no longer bothers us.

Baltimore, Md. WM. T. CONLEY.

Pump Valve and Seat Refacer

REFACING the valve seats of small duplex pumps is easily accomplished by a tool of the type which I have made and used successfully for many years. The construction as shown by the sketch consists of an upper guide, a disc with a stem for turning the tool and acting as a guide-pin below. The tool itself is made of a fine cut file annealed, drilled and rehardened and then fastened to the disc with two machine screws. The top another guide is bolted to the

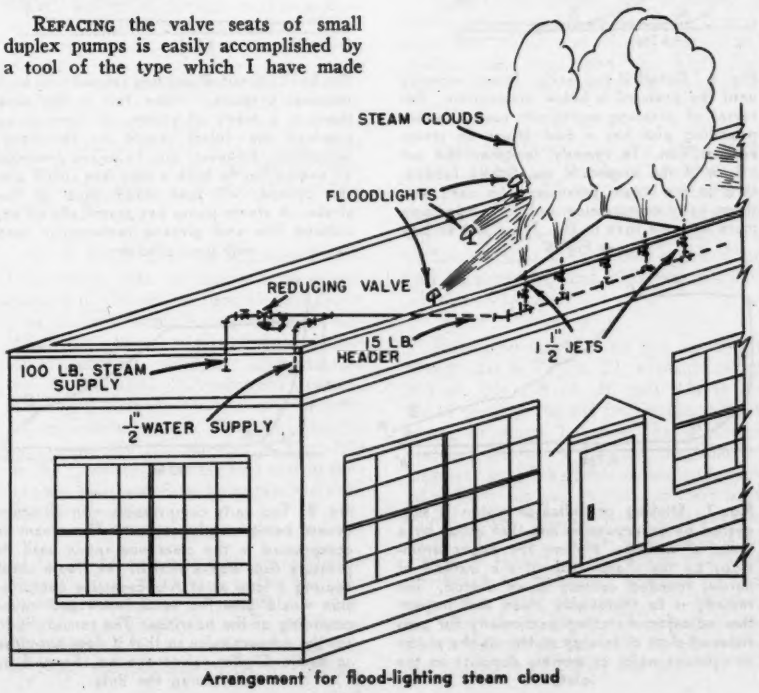


Valve seat refacer made from a file

valve chamber. The tool may be turned either with a brace or with an electric drill.

The file can be annealed by heating to a dull red then placing it in a box of lime or ashes until cold. After it is drilled and shaped, care should be exercised not to damage the file while it is soft. To temper again, heat to a dull red and quench in cold water. I also use tools made from fine cut files for refacing valve discs.

Seattle, Wash. HARRY KAMMEYER



Arrangement for flood-lighting steam cloud

Engine Troubles—Indicated and Diagnosed

By ROY L. BROWN

FROM THE EARLY DAYS, the steam engine indicator has been of inestimable value to the engineer but many of the present generation have neglected to learn its numerous advantages. The indicator is to the engineer what the X-ray is to the doctor—tells what is going on inside of the cast-iron cylinder and a thorough study of the small diagrams shown on the piece of paper usually tells an experienced engineer where the trouble lies.

Most engines are provided with a ½ in. tapped opening for the indicator connection. The piping should be as short as possible, free from obstruction and provided with a three-way cock for attaching the indicator. Globe valves should never be used in the indicating piping.

Each spring is numbered with a scale showing the pressure required to give 1 in. vertical movement of the pencil. As a rule the spring scale should be selected about one-half the maximum steam pressure so as to get a good shaped card and to reduce the planimeter errors.

When the eccentric is moved it is best to move it about ½ in. in the proper direction; take another card and check the result. This deliberate method of procedure avoids undue changes which might cause serious difficulty and also gives the engineer a chance to see just how each change affects the indicator card.

Last of all keep the indicator clean, well oiled and in good working condition for an inaccurate, unreliable instrument is worse than useless. When an engineer depends on the indicator to tell the story—the story must be dependable.

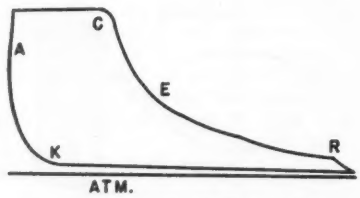


Fig. 1. A nearly perfect indicator diagram. AC, admission line; C, cut-off; CER, expansion line; R, release; K, compression; ATM, atmospheric line. When a chart or diagram approaches this the engine from which it was taken will in practice give good results. Unfortunately cards are not always as good as this and the engineer must use skill in interpreting the diagram and making adjustments

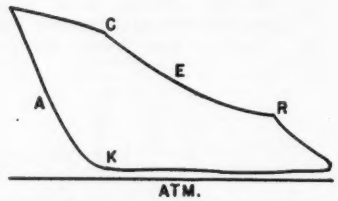


Fig. 2. All events are too early. With a single slide valve engine this can be remedied by shifting the eccentric backward. With Corliss valve gear, the links can sometimes be moved to give the steam valve more lap without moving the eccentric. The steam line also shows excessive pressure drop which may be caused by a small line or too great a distance between the engine and boiler

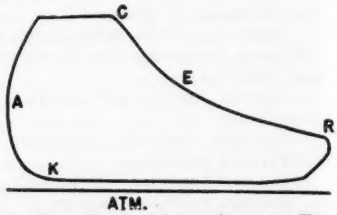


Fig. 3. The effects of late admission. This can be remedied by shifting the eccentric ahead on the shaft. If a Corliss type engine, the steam lap can be reduced by shortening the links, although it may be necessary to shift the eccentric also. The effect of late admission is not so severe as early admission but in extreme cases may result in the loss of power and increased water rate

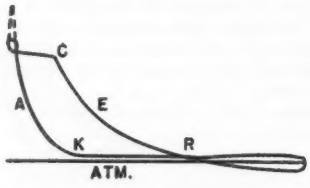


Fig. 4. Cutoff is too early. Steam expands until the pressure is below atmosphere. Reversal of pressure sometimes causes severe pounding and has a bad effect on steam consumption. To remedy, lengthen the cut off, or if the engine is too lightly loaded, throttle the steam pressure. This card also shows early compression and early admission more extreme than in Fig. 2 but not as bad as Fig. 8

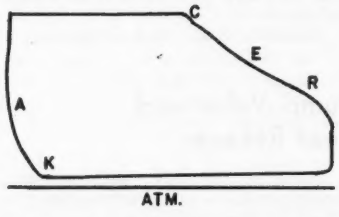


Fig. 5. Late cutoff and late release with high terminal pressure. When this is the case there is a waste of steam. If there is no overload the cutoff should be shortened. Sometimes, however, due to heavy overload an engine has to have a very late cutoff and the cylinder will take steam most of the stroke. A steam pump has practically no expansion line and gives a rectangular card with poor efficiency.

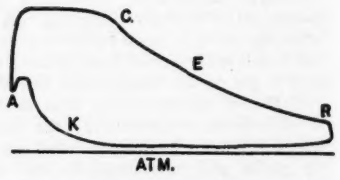


Fig. 6. A hook in the compression line as at A indicates that the steam is leaking, either past the rings or through the exhaust valve. If the engine is of the slide valve type the valve plate may be warped. Engines with a diagram of this kind are subject to heating and pounding in the brass and quarter bearings. Loss of compression may cause high maintenance. Remedy: Check the rings and valves for tightness

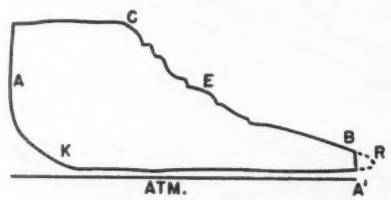


Fig. 7. Sticking of indicator piston is suggested by an expansion line that drops by a series of notches; striking the paper drum-stops by the sharp drop of a-b instead of normal rounded corners shown dotted. The remedy is to thoroughly clean and inspect the indicator, watching particularly for particles of cloth or foreign matter on the piston or cylinder walls, or gummy deposits on the joints

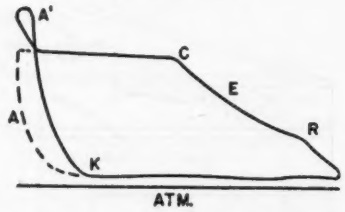


Fig. 8. Too early compression with all other events being nearly correct. The steam is compressed in the clearance space until its pressure rises above that of the steam chest causing a loop as at A^1. Excessive compression would give the same result and cause pounding of the bearings. The remedy is to set the exhaust valve so that it does not close so early. Corliss valves can be changed by shortening the links

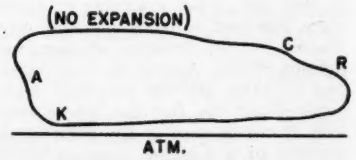
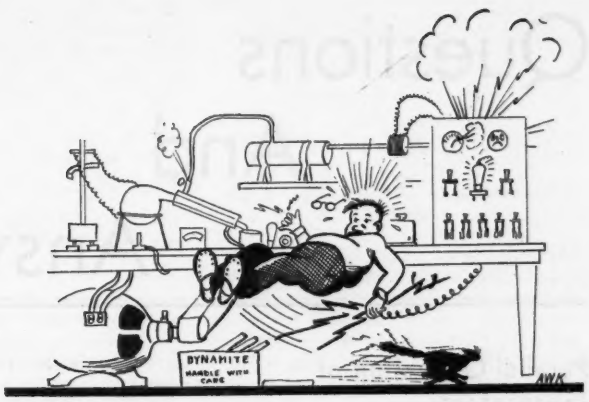


Fig. 9. Example of how the indicator can be used to correct engine performance. This engine was nearly new but failed to pull the load. The engine exhausted under water. Remedy: The exhaust was raised from its watery grave, the steam line was covered with 2½ in. of lagging; the steam was superheated; and a jet condenser was installed. The engine then pulled its load easily as it was designed to do

. . . SHORTS . . .



All types of fuel require about 7.5 lb. of air per 10,000 B.t.u. for perfect combustion but this must be increased from 10 to 100 per cent in practice. 7.5 lb. of air per hr. at atmospheric pressure and temperature is roughly 1.6 cubic feet per minute.

* * *

Auxiliary power, as a percentage of the gross power generated, ranges as follows in the better plants: gas and oil firing 3.5 to 4; stoker firing 4 to 5; pulverized coal firing 5.5 to 6.5.

* * *

Costs of small 450 lb. pulverized coal fired boilers, erected complete with pulverizers, fans and air heaters, can be figured quite closely as 60c per pound of steaming capacity per hour plus a base price of $30,000. Thus a 100,000 lb. per hr. unit—(0.60 × 100,000) + 30,000 = $90,000. For 650 lb. boilers increase the base price $15,000.

* * *

Fuel consumption of a well operated Diesel engine in gallons per hr. should be about C(0.02 + 0.06 P) where C is the rated capacity in kilowatts and P is the ratio of average load to the capacity. Thus in a 200 kw. unit operating at an average load of 150 kw., C is 200, P is 150/200 = 0.75 and the fuel consumption 13 gal. per hr. This is about 11.5 kw-hr. per gal. At 100 kw. load the total consumption would drop to 10 gal. and the output per gallon to 10 kw-hr.

* * *

Oil treating of coal for the elimination of dust introduces complications where belt conveyors are used for oil causes rapid deterioration of rubber. The Stamford Gas & Electric Co. found that 5 mo. service ruined the rubber belt and switched to a neoprene covered belt which has now been in service over a year.

* * *

A year ago the New Method Laundry of Toronto installed a two drum 315 hp. Erie City boiler fired by a single retort stoker and increased the evaporation from approximately 8 to slightly over 10 lb. of water per lb. of coal. With this encouragement a 229 hp. unit of the same type was rebuilt and tests showed an evaporation of 10.576 lb.

A 200 kw. back pressure turbo-generator installed in a textile plant to act as a reducing valve was reported to have cost $12,000 and saved $14,176 in 38 mo. operation—a saving of over 37 per cent per year on the investment.

* * *

H. E. Graham of Fairbanks, Morse analyzed a "Diesel vs. Purchased Power" problem for the North Carolina Ice Association and reached the following conclusion: "If all items of cost are considered the savings by using Diesel power is approximately the difference between the cost of fuel and lubricating oil for the Diesel and the total of the monthly power bills. Don't permit the issue to become complicated with discussions of depreciation, maintenance, labor costs, repair bills, etc. Those have all been taken into account in our present comparison." Total cost per ton of ice as he figured it was $0.77½ for Diesel as compared to $1.30 for purchased power, a difference of 52½c. Without considering overhead the figures were $0.35, $0.95 and $0.60 respectively. Looks as though a little actual data might prove to be of interest.

* * *

What is a reasonable record for boiler availability? G. G. Post of Milwaukee says that over an 8 yr. period the four high pressure boilers at Lakeside have averaged 94.2 per cent, the lowest being 90 per cent for No. 17, the highest 96.2 for No. 20.

* * *

B. E. Miller told the Midwest Power Conference that an analysis of actual costs of private utility rural electrification lines showed the following price of material and labor per mile of line: 2 customers per mi., $816.59; 2.3 customers per mi., $860.65; 2.6 customers per mi., $904.71; 3.0 customers per mi., $963.46; 3.3 customers per mi., $1007.52. For the mathematically minded this is T = 670 + 147 C where T is the total cost in dollars per mile and C is the number of customers per mile.

* * *

To be of use power plant statistics must be, A. L. Rice said to the Midwest Power Conference: "Accurate . . . complete . . . and simple . . . when cost determination enters, the work can generally be most economically done by the accounting department if engineers will state clearly what facts they need, why these are needed, how they can be used and explain the form desired. If you don't get along with the accounting department perhaps you are not doing your part.

* * *

Pump models for the Los Angeles-Colorado River aqueduct, developed maximum efficiencies of from 90.9 to 92.6 per cent and the detailed studies and investigations are said to have added about 3 per cent to the performance.

* * *

Discussing steam transmission and distribution lines, F. Elwell, Works Engineer of the Buick Plant, said that when "drop in pressure is not a serious matter . . . pipe line sizes can be kept at a minimum allowing the pipe to serve as a reducing valve. Cases have been known where the velocity of steam in such instances was stepped up as high as 30,000 ft. per min."

* * *

Even with cheap fuel available a boiler efficiency of 80 per cent is economically sound and 85 per cent is advisable with base load and high fuel costs, said G. A. Gaffert of Sargent & Lundy.

* * *

Earl MacDonald of the Pere Marquette Hotel in Peoria, Ill., discussing the application of Diesels to hotel service said "Experience has shown that with everything ready to operate, the initial installation can be expected to cost between $90 and $130 per kilowatt of plant capacity."

* * *

Hydrogen sulphide in the sludge or sewage gas at Peoria, Ill., averages about 115 gr. per 100 cu. ft. and this is reduced to 10 gr. by the iron oxide purifier boxes in mains between the digesters and gas holder. J. R. Longley, district engineer says "the total capital and operating costs for gas purification have been found close to 1.5c per thousand cu. ft. of gas. . . . Only slight traces of pitting of engine parts which might be attributed to hydrogen sulphide in the gas have been observed . . . whether the cost of purification has been justified is difficult to say with certainty . . . we believe the District has profited."

Questions And Answers

Parallel Operation of Generators

Q. At the present time we are operating two direct current generators, each feeding a separate circuit. One of these units is a 150 kw., 250 v. direct current generator direct connected to a 3 phase, 1200 r.p.m. 2300 v. synchronous motor, while the other is a 175 kw. 250 v. machine direct connected to a 250 r.p.m. uniflow engine. Would there be any difficulty in operating these two machines in parallel. I realize that the series field coils would have to be balanced as to the resistance on each machine but I am wondering if the wide difference in speed might not affect the regulation of one or the other to an extent that they would not divide the load properly. The load on both circuits has a tendency to fluctuate considerably.

Bound Brook, N. J. J. V.

A. There should be no difficulty in operating these machines in parallel. Regardless of what adjustments are made it probably will be found that the high speed machine will take the load swings. In order to obtain proper load division with slow variations in load, the customary adjustments of compounding the drop should be made. The first adjustment, obtained by the use of proper series field shunts, provides the same change in voltage from no load to full load when the generators are operating independently. The second adjustment involves equalizing the IR drops over the series fields with the two generators operating independently. This may involve the use of additional resistance in one of the series field circuits. Finally, it is very essential to have the resistance in the equalizer cables and connections negligible in comparison with the series field resistance. If these adjustments are made the machines can be operated in parallel without fear of trouble.

Finding the Quality of Exhaust Steam

Q. How can I find the quality of the steam in the exhaust of a steam turbine so that I may calculate how much heat is going into the condenser? The Mollier diagram should give the theoretically correct answer but it is not correct from a practical standpoint because of reheating. How is this reheat factor determined? F. M.

A. The quality of steam in the exhaust of a steam turbine cannot be determined directly but must be computed from the heat content of the entering steam, the radiation and bearing losses of the turbine, the efficiency of the generator and the electrical output of the unit. In the case of a fairly large unit, the efficiency of the generator can be computed by means of the following equation.

$$0.98 - \frac{0.055}{\sqrt[3]{(\text{kw. rating} \div 1000)}} \times \frac{\text{rating}}{\text{load}}$$

and the mechanical losses, that is bearing friction, radiation losses and oil pump requirements, can be taken as equal to

$$\text{Per cent of normal rating} = \frac{40}{\sqrt{(\text{kw. rating} \div 1000)}}$$

This is in per cent of normal rating of the turbine and remains about constant regardless of the load.

Working backward from the electrical load carried and the heat in the entering steam, the amount of heat accounted for in electrical energy, generator and mechanical losses can be approximated and the amount of heat going to the condenser can be computed, obviously, as heat which passes the throttle and is not converted into useful work or friction losses, and must appear at the exhaust of the turbine and go to the condenser.

If by the Mollier diagram you mean theoretical adiabatic expansion, you are correct in your statement; but this expansion line is not correct. The error, however, lies not in reheating, but in the stage or nozzle efficiency of the turbine itself. Reheating tends to throw the expansion line closer to the theoretical.

In general it may be said that the efficiency of a turbine is 10 per cent higher in the superheated than in the saturated area. If, therefore, the steam consumption of the turbine at any point is known, the expansion line of the turbine through the entire area or range can be plotted, first by locating the exhaust condition as computed from the steam consumption of the turbine and then by a cut and try method lay out two lines, one from the entering steam condition down to the saturation curve, the other line from the saturation curve to the exhaust condition. The slope of these two lines should be such that that portion lying in the superheated area would give a 10 per cent greater efficiency than that in the saturated area. Details regarding the calculation of these curves, generator efficiencies and losses are given in a paper by Brown and Drewry in the 1923 volume of the A. S. M. E. Transactions.

By accurate measurements, the expansion line of the turbine can be plotted on a Mollier chart and the heat content of the steam at various points in the expansion, obtained in this manner. These data may be obtained by tests at various extraction points in an extraction turbine or they can usually be plotted from data supplied by the manufacturer.

It is true that the internal losses in the first part of the turbine are reconverted into heat and partially utilized by the lower stages of the turbine; that is, the energy lost in friction and eddies in each stage goes at once into heat and is absorbed by the steam so that it is available as heat energy for partial recovery in all the following stages. For this reason, the summation of the available heat drop in the individual stages always exceeds the overall heat drop. The reheat factor is the ratio of the summation of heat drop in each stage to the overall heat drop and furthermore, since the average stage efficiency is computed relative to the summation while the turbine efficiency is computed relative to the overall heat drop, it follows that the ratio of turbine efficiency and stage efficiency is also the reheat factor.

This reheat factor depends not only on the initial and final steam conditions, but on the shape of the condition curve as well. That is, upon the relative efficiency through various stages. If the early stages show poor efficiency, the reheat factor will be slightly larger and the average stage efficiency slightly lower than in another turbine of the same efficiency in which the initial stages are relatively good. In modern multi-stage turbines the condition of expansion and uniform stage efficiency is approximated.

Lifting Hot Water

Q. Is it possible to lift water at a temperature of 160 deg. to a height of 6 ft. by means of a direct acting steam driven vacuum pump? This pump is used in a steam heating system, the pump being located in the boiler room some distance from the building to be heated. The vertical lift is 6 ft. and the pipe line has two 90 deg. elbows. In discussing the matter with other engineers, some seem to think that it can be done while others are of the opinion that it cannot be done.

Chicago, Ill. J. B.

A. In general, both opinions are correct, assuming, of course, that the pipe line is large enough so that the friction loss is small. Theoretically, water at 160 deg. F. can be lifted about 23 ft. In practice however, this elevation cannot be obtained and it is generally stated that the maximum lift under favorable conditions is about 5 ft. at 165 deg. While

for dependable service, such as boiler feed work, it is best to have no suction lift at all at this temperature. These figures are for operation at sea level. Altitude has a considerable effect.

Assuming the proper size pipe, the answer to your question depends entirely upon the kind of pump being used. If the valves are too heavy or too heavily spring loaded you would undoubtedly have difficulty but, with proper valves or with a rotary or centrifugal pump properly installed you should have little difficulty. If the temperature runs considerably above 160 deg. it will be advisable to install some kind of an overflow to the sewer, so that if the pump should lose its suction, no damage will be done by the water in the basement of the building to be heated.

Boiler Questions

Q. WHAT is the proper procedure to bring a boiler into service in parallel with other boilers already under pressure?

A. The usual procedure is as follows:

1. Remove all danger or Out of Service signs from valves and equipment controls; inspect boiler setting doors to see that they are closed and the blowoff to see that blow-off valves are closed and that the safety stop gate valve, if one is connected, is open. See that valves controlling water column, gage glass and pressure gages are open and water-column blow-down valves are closed.

2. For a boiler having separate economizer, see that valves between boiler and economizer and the economizer vents are open; open all vent valves and close all drain valves from the boiler. Open the water feed valve slowly, one or two turns and fill the boiler to the proper water level. (Usually about half the height of the water gage glass.) If a superheater is installed, operate its drains according to instructions of the boiler room chief.

3. Start the fire slowly according to regular procedure for hand-fired, stoker-fired or pulverizer-coal-fired. See that the change-over valve on the water-back lines is set for raw water and that feed and discharge valves on water back are open. Bring up the fire gradually and as soon as gas and air are driven out of the boiler, close all vent valves.

4. Watch pressure gage, and feed-water regulator, if one is used, to see that they are working properly. It may help circulation to operate the blow off at say 25 lb. and at 50 lb. pressure. Test the safety valve by lifting it when pressure reaches ¾ working pressure, to blow scale or dirt off the seat.

5. Bring pressure up gradually to a little lower than header pressure, then open the main stop valve, so that any condensation will be blown back into the boiler. An alternative method where automatic non-return valve is installed is to open the drain valves, open the main stop valve bypass and blow out all water between main and automatic valves. Then close drain valves and open the trap line valve above the automatic non-return; open the main stop valve and close its bypass. Increase the fire until the boiler begins to steam, keeping the fire light and putting the boiler into service as gradually as conditions permit. Finally, set the change-over valve on water back line for condensate, blow down water-column to check water level, test safety valve by lifting and cut in automatic boiler feed control.

If a boiler is already filled and the fire banked, procedure will start with section 3.

Q. WHAT PRECAUTION is necessary to protect a superheater from overheating before a boiler is cut into service?

A. In older practice, superheaters were flooded, but experience has shown that if circulation is maintained, this is unnecessary. The vent on the superheater should be left open until the boiler is cut into service, thus ensuring circulation of steam through the superheater, and the superheater safety valve set to blow at some 2 lb. below the main safety valve, so that circulation will be maintained during no-load or low-load periods when the safety valves might blow and little or no steam passes through the superheater.

Transformer Connections

Q. IN OUR plant we have a number of 3 phase, 250 v. motors which we would like to operate. I would like to know whether these motors could be supplied from the present delta connected transformers which are connected as shown in the diagram Fig. 1. Can we obtain 250 v. 3 phase taps from this arrangement without interfering with the 550 v. motors? What changes are necessary to cut out one of these transformers, temporarily?

A. It is possible to operate your 250 volt three-phase motors satisfactorily across the half voltage taps of your 550 volt transformer secondary without interfering with the 550 volt motors, provided you are not overloading the half-voltage taps. If half the rated kv-a of the bank is connected to the full voltage leads as shown in Fig. 1 an additional load of 32.5 percent of the normal rating may be connected to the half voltage leads, assuming that the two loads have the same power-factor. When using only a three-phase load, connected to the half-voltage taps, the transformers will give half their kv-a. output without overheating. With your present transformer connections, it is quite simple to cut out any one of the three transformers and still have a three-phase system. By disconnecting the primary terminals of any one of the transformers at points A, A′ as shown in Fig. 2, and the secondary at points B B′ the remaining two transformers will be connected open delta.

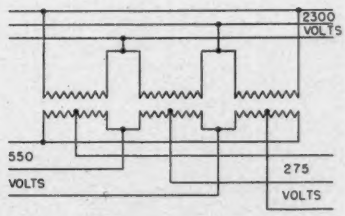


Fig. 1. Transformer connections to obtain half voltage

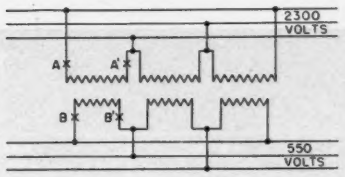
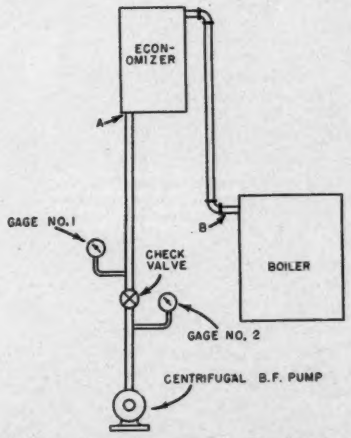


Fig. 2. Showing how one transformer may be removed

Effect of Static Head on Gage Readings

Q. WOULD gage No. 1, as shown in the accompanying sketch have to be corrected for a static head where water enters the boiler? Also, with a check valve located in the line as indicated, would gage No. 2 have to be corrected for static head or would the check valve eliminate the necessity for correction, assuming the boiler feed pump to be running?

Athol, Mass. H. S. GOULD.



Check valve prevents opposite flow but does not affect positive pressure

A. To obtain the pressure at the entrance to the economizer, it is necessary to correct either gage for the height in feet to A as shown in the sketch, divided by 2.31. The check valve has no influence on the pressure shown by gages in the line under the check valve.

Flow through the economizer is accompanied by a certain amount of friction, therefore, to obtain the pressure at the entrance of the boiler, it is necessary to correct for the height to B minus the friction due to passing through the pipes in the economizer, that is the difference in the heights of A and B is balanced in the up and down pipes.

THE LIFTING CAPACITY OF TACKLE

LIFT TONS	RIGGING 1" MANILA ROPE		LIFT TONS	RIGGING 1¼" MANILA ROPE		LIFT TONS	RIGGING 1½" MANILA ROPE		LIFT TONS	RIGGING 2" MANILA ROPE	
2	SINGLE 2 PARTS SINGLE	2 PARTS SINGLE	4	SINGLE 2 PARTS SINGLE	2 PARTS SINGLE	5	SINGLE 2 PARTS SINGLE	2 PARTS SINGLE	21	TRIPLE 6 PARTS TRIPLE	DOUBLE 6 PARTS TRIPLE
3	DOUBLE 3 PARTS SINGLE	SINGLE 3 PARTS SINGLE	5	DOUBLE 3 PARTS SINGLE	SINGLE 3 PARTS SINGLE	7	DOUBLE 3 PARTS SINGLE	SINGLE 3 PARTS SINGLE	23	QUADRUPLE 7 PARTS TRIPLE	TRIPLE 7 PARTS TRIPLE
4	DOUBLE 4 PARTS DOUBLE	SINGLE 4 PARTS DOUBLE	7	DOUBLE 4 PARTS DOUBLE	SINGLE 4 PARTS DOUBLE	9	DOUBLE 4 PARTS DOUBLE	SINGLE 4 PARTS DOUBLE	25	QUADRUPLE 8 PARTS QUADRUPLE	TRIPLE 8 PARTS QUADRUPLE
5	TRIPLE 5 PARTS DOUBLE	DOUBLE 5 PARTS DOUBLE	8	TRIPLE 5 PARTS DOUBLE	DOUBLE 5 PARTS DOUBLE	11	TRIPLE 5 PARTS DOUBLE	DOUBLE 5 PARTS DOUBLE	27		QUADRUPLE 9 PARTS QUADRUPLE
			9	TRIPLE 6 PARTS TRIPLE	DOUBLE 6 PARTS TRIPLE	12	TRIPLE 6 PARTS TRIPLE	DOUBLE 6 PARTS TRIPLE			
						13	QUADRUPLE 7 PARTS TRIPLE	TRIPLE 7 PARTS TRIPLE			
						14	QUADRUPLE 8 PARTS QUADRUPLE	TRIPLE 8 PARTS QUADRUPLE			

Wooden Shell Blocks with Manila Rope — a Few Common Systems Employed by Riggers

LIFT TONS	LEAD LINE PULL POUNDS	RIGGING ⅝" WIRE ROPE		LEAD LINE PULL POUNDS	RIGGING ¾" WIRE ROPE		LEAD LINE PULL POUNDS	RIGGING ⅞" WIRE ROPE	
10	5,700	DOUBLE 4 PARTS DOUBLE	SINGLE 4 PARTS DOUBLE	7,400	DOUBLE 3 PARTS SINGLE	SINGLE 3 PARTS SINGLE	7,500	DOUBLE 3 PARTS SINGLE	SINGLE 3 PARTS SINGLE
20	8,500	TRIPLE 6 PARTS TRIPLE	DOUBLE 6 PARTS TRIPLE	9,800	TRIPLE 5 PARTS DOUBLE	DOUBLE 5 PARTS DOUBLE	11,000	DOUBLE 4 PARTS DOUBLE	SINGLE 4 PARTS DOUBLE
30	10,600	QUADRUPLE 8 PARTS QUADRUPLE	TRIPLE 8 PARTS QUADRUPLE	11,700	QUADRUPLE 7 PARTS TRIPLE	TRIPLE 7 PARTS TRIPLE	13,800	TRIPLE 6 PARTS TRIPLE	DOUBLE 6 PARTS TRIPLE
40	10,700		SIX SHEAVE 13 PARTS SIX SHEAVE	13,400		QUADRUPLE 9 PARTS QUADRUPLE	15,000	QUADRUPLE 8 PARTS QUADRUPLE	TRIPLE 8 PARTS QUADRUPLE
60				16,600		SIX SHEAVE 13 PARTS SIX SHEAVE	19,000		5 SHEAVE 11 PARTS 5 SHEAVE

Steel Shell Blocks with Wire Rope — Best Crucible Cast Steel Hoisting Rope, 6 strands, 19 wires to a strand and Hemp core

THE EFFICIENCY of a block and tackle rig depends largely on the size and flexibility of the rope and the diameter and the number of sheaves. In any particular case it is desirable to know what kind of rig to use and how much pull on the deadline is necessary to raise the required weight. The accompanying diagrams and data for which the McClintic-Marshall Co. is authority, give the safe lifting capacity and fall line pulls on some of the more common systems of block and tackle.

12 in. blocks for 1 and 1¼ in. manila rope.
Capacity of blocks with hook:
Single—5 tons, Double—7 tons; Triple—8 tons.
Approximate pull on lead line:
1 in. rope—1 ton, 1¼ in. rope—2 tons, 14 in. blocks for 1½ in. rope.
Capacity of blocks with hook:
Single—6 tons, Double—10 tons, Triple—12 tons.
Capacity of Blocks with shackle: Quadruple—14 tons.

Approximate pull on lead line, 3 tons.
20 in. Blocks for 2 in. manila rope.
Capacity of Blocks with shackle:
Single—15 tons, Double—22 tons, Triple—30 tons.
Quadruple—35 tons.
Approximate pull on lead lines, 5 tons.

These values are only for tackle as shown. If lead line is snatched or passes over additional sheaves, capacity diminishes.

Air Heater and Economizer Selection

Part II. In the first article in the May issue, the theoretical factors effecting selection of air heaters and economizers were discussed. This article deals with the application of these factors to the determination of the relative sizes of each type of heat trap and of the practical factors which limit the actual design.

By ADOLPH JOHNSON

HAVING COVERED the main points incident to the problem of selecting economizers and air heaters, the question of which one to select for specific requirements can now be dealt with. These theoretical factors can be summarized in the order of their importance as: Availability; transfer rate, and draft loss.

These are theoretical considerations, implying of course that there are practical limitations of equal importance such as available space conditions, type of firing, the balancing of cost against over-all thermal efficiency, and the cost of fuel. If the fuel cost is very high, the theoretical limitations are the main limiting factors in striving for a high thermal efficiency. We shall consider this condition first. A typical numerical example will probably more clearly bring out the essential points to consider in selecting an economizer or air heater or both. Three cases will be presented which will show just which type of heat trap is best suited in each case, based, of course, on unlimited space available, unlimited air temperature and high fuel cost.

CASE I.

Weight of gas leaving boiler, 50,000 lb. per hr.
Weight of steam leaving boiler, 40,000 lb. per hr.
Weight of combustion air, 42,000 lb. per hr.
Temperature of Flue Gas leaving boiler, 550 deg. F.
Required gas temperature leaving economizer or air heater, 350 deg. F.
Feedwater temperature, 325 deg. F.
Room air temperature, 80 deg. F.

From this data and by applying the principles previously discussed in Part I, we can calculate the heating surface required to obtain 350 deg. F. exit gas temperature. We shall assume the same transfer rates of 4 and 12 for air heater and economizer respectively. The required air heater surface would be:

$50{,}000 \times (550\text{-}350) \times 0.26 \div 4 + 239 = 2720$ sq. ft.

The economizer surface required would be:

$50{,}000 \times (550\text{-}350) \times 0.26 \div 12 \times 73 = 2960$ sq. ft.

Since the cost per square foot is much higher for economizer surface than air heater surface, this case would be in favor of the installation of an air heater. The fundamental reason for the rather large economizer surface is that the feedwater temperature is too high and therefore the availability is too low for economic recovery of heat via the feedwater. This is very apparent if reference to the above heating surface calculations is made. The log mean temperature difference t_m for the air heater is 239 deg., whereas for the economizer the availability is only 73. The mean temperature differences are based on counterflow of heat transmitting and receiving mediums.

CASE II.

Assume identical gas weight and air flow as Case I, and the following temperatures

$T_1 = 750$ deg. F.—gas temperature entering
$T_2 = 400$ deg. F.—required gas temperature leaving
$t^1_1 = 80$ deg. F.—temperature of air entering
$t_1 = 210$ deg. F.—temperature of feedwater entering

Required air heater surface

$50{,}000 \times (750\text{-}400) \times 0.26 \div 4 \times 263 = 4310$ sq. ft.

Required economizer surface

$50{,}000 \times (750\text{-}400) \times 0.26 \div 12 \times 292 = 1300$ sq. ft.

The required economizer surface in this case is so much smaller than the air heater surface that the cost would be in favor of the economizer. Again the availability plays an important part in the selection. The gas temperature drop of (750-400 deg. F.) is so high that the air temperature rise lowers the availability in the air heater too much for it to compete successfully with the economizer. Since the feedwater temperature is comparatively low and the specific heat of water rather high, it works out that the economizer availability is higher than for the air heater. The difference in heat transfer rates between the two heat traps combines with the availability in this case to decide in favor of an economizer.

CASE III.

Assuming the same gas, water, and air weights, and the following temperatures:

$T_1 = 750$ deg. F.—gas temperature entering
$T_2 = 300$ deg. F.—gas temperature leaving
$t^1_1 = 80$ deg. F.—air temperature entering
$t_1 = 400$ deg. F.—feedwater temperature entering

Required air heater surface

$= 50{,}000 \times (750\text{–}300) \times 0.26 \div 4 \times 149 = 9800$ sq. ft.

Required economizer surface.

$50{,}000 \times (750\text{–}300) \times 0.26 \div 12 \times 0 =$ infinite surface

Since the feed temperature is higher than the required exit gas temperature, it would be impossible to design an economizer to obtain the 350 deg. F. exit flue gas temperature required.

However, the air heater surface required is out of all proportion to the heat absorbed. This is a case where it is well to consider a combination of both economizer and air heater. If the economizer and air heater are each designed to absorb about half the total heat, a reasonable and economic design would be achieved. That is, if the economizer would drop the flue gas temperature from 750 to 550 deg. F., and the air heater absorb the remaining heat required to obtain 300 deg. F. exit gas temperature, the heating surfaces would be:

Economizer—1030 sq. ft.
Air heater—4450 sq. ft.

Even if economizer surface costs as much as 3 times that of air heater surface, the total cost of the combination of the two is less than if an air heater alone is designed for the requirements. In addition to this, the necessity of designing burners and hot air ducts for a fantastic air temperature (exceeding 600 de-

grees) has been eliminated by the use of both economizer and air heater.

Outside of the theoretical considerations in selecting air heaters and economizers, there are certain practical limitations which may or may not be the deciding factor in the final choice of one or the other.

Suppose, for instance, that the boiler is to be fired by a stoker. As a rule, air temperatures to a stoker are limited to 250 to 350 deg. F. Since the air weight required for combustion is always lower than the flue gas, it is evident that an air heater in this case would be limited to a heat absorption which would drop the gas temperature less than the maximum allowable air temperature to stoker minus the room temperature.

If higher efficiency is desired than that which would result due to the limited air temperature, then an economizer would be required for the additional savings desired. Another practical limitation is the available space conditions for installation of additional heat absorbing equipment. This is important not only if the units are to be installed in an existing building but also where a new building is to be designed to house the steam generator and associated equipment.

If the space limitations are due to installation in an existing building and the limit is such that the maximum economic heat recovery would call for economizer or air heater or both, which would require more space than is available, it is then a question of installing as much surface as can be accommodated. A comparison of the cost, taking into consideration the maximum heat recovery for each type, will determine whether an economizer or air heater or both should be installed.

If it is proposed to house the new steam generator in a new building or revise an old building to accommodate additional heat recovery equipment, then the cost balance of heat recovery apparatus against thermal efficiency must include the cost of each addition in building space required to house the additional heating surface for each increase in thermal efficiency that would be obtained.

Pulverized coal firing also presents certain inherent design factors which effect to some extent the size of air heater. This is true because the pulverizer requires an air input to sweep the pulverized coal out of the mill to the burners. This is known as the primary air. If all the primary air can be taken as hot air direct from the air heater, then all the air required for combustion (i. e., both primary and secondary air) passes through the air heater. However, the temperature of the primary air to the pulverizer is limited. If the temperature is too high, the coal in the pulverizer tends to coke and release volatiles so that the coal particles become sticky and clog the operation of the mill.

To limit this temperature to satisfactory level a certain amount of tempering or cold air is taken direct from the forced draft fan to mix with enough hot air from the air heater to make up the total primary air at the correct temperature required to dry the surface moisure from the coal and still low enough to prevent coking of the coal. The higher the air temperature leaving the air heater is above that required for the primary air, the more tempering air is required. The more tempering air required, the less air goes through the air heater. The result of this is that the gas weight to air weight ratio in the air heater increases, which for the same heat recovery means a higher air temperature leaving the air heater. The higher air temperature results, therefore, in lower availability.

Summing up the involved variations mentioned above, the net result is: the more tempering air required by the pulverizer, the larger the air heater must be to obtain the required absorption.

Air Leakage

Another factor effecting air heater size is infiltration of air to the setting. To keep air heater availability as high as possible, the gas weight to air weight ratio should be kept as low as possible. The ideal condition is when all air that enters the furnace goes through the air heater. If air leaks through the boiler and furnace setting, it does not go through the air heater, the gas weight is increased, while the air through the air heater remains constant, thus increasing the gas to air weight ratio and hence lowering availability in the air heater. Infiltration is not a predictable factor and depends entirely on the care which is taken in making the setting of the unit air tight.

The most important practical consideration, however, is the cost of fuel. It is no doubt needless to say that high thermal efficiency means nothing if the fuel cost is so low that an economizer or air heater cannot be justified. This is usually true of low grade bituminous coals, lignite, bagasse, wood and numerous types of waste product fuels. However, the units are very often arranged for auxiliary oil firing for the periods when the supply of low cost fuel is running too low to supply the plant's steam requirements. In such a case, an air heater might be justified, but only after a detailed analysis which would show that the high cost auxiliary fuel is being used in sufficient amounts to justify investing in additional heat absorbing equipment as well as the increased power required for drafting the additional equipment.

As stated before, each case must be dealt with as an individual problem. The preceding discussion is an effort to separate all the individual factors which enter the complex problem of selecting heat absorbing equipment for maximum economic return. The combinations of these factors as well as others less frequently encountered is almost limitless. It is only by an ability to take a specific problem and recognize these primary considerations that one can intelligently arrive at a satisfactory solution or to see if a satisfactory solution has been reached. It is hoped that this elementary analysis of the subject is of some value to those who, faced with the problem of reducing plant expenditure, were not previously equipped to analyze the problem or to properly select, if several solutions are presented, which is the best to adopt for their own particular circumstances.

A future and final article will deal with the economics and maintenance factors involved in proper selection of air heaters and economizers. It will illustrate how cost and life of the heat absorber determine the ultimate design and type to be selected.

Brewery Plant Modernization

By WILLIAM SCHULER

Plant Engineer
Jacob Ruppert
New York, N. Y.

WHEN REPLACING the old power plant which had been serving the Jacob Ruppert brewery for the past 30 yr., advantage was taken of the savings made possible by bleeder type turbines for supplying brewery steam requirements. The old plant consisted of five stoker fired boilers which generated steam at 125 lb. for process and engine room use. Machinery in engine room consisted of a 500 kw. d.c. geared turbine generator, two 300 kw. d.c. reciprocating engine driven generators and 1400 t. of steam driven ammonia compressors. Principal process requirement was for 125 lb. steam for four 700 bbl. wort cookers and for the grits cookers.

These brew house kettles are now heated with 25 lb. steam bled from Westinghouse turbines instead of direct from boilers as under the former set-up. The new installation of bleeder type turbines is effecting large savings. Steam is generated by three Combustion Engineering pulverized coal fired boilers, each with a total boiler and water wall surface of 7330 sq. ft. and is operated at 400 lb. ga., 625 deg. F. T.T. Two boilers are sufficient to handle peak load. A Gifford Wood 900 t. coal bunker provides overhead storage. A Buell collector has been installed for fly ash elimination.

Principal turbine room equipment consists of two 2000 kw. double automatic bleeder type condensing turbines and one 1000 kw. single automatic bleeder condensing turbine, a combination of sizes which provides flexibility, reliability and high operating efficiency, for most maximum loads can be carried on a combination of two machines leaving one for standby. Each turbine receives throttle steam at 400 lb. and 600 deg. F. and exhausts into a condenser at a 28 in. vacuum. Direct coupled to each turbine is a turbo-generator with direct connected exciter.

The 1000 kw. turbine designed to carry week-end loads has one extraction point at 30 lb. ga. Each of the two 2000 kw. units has a high pressure bleed point at 115 lb., and a second bleed point at 30 lb. Extraction steam at 115 lb. is used in steam driven refrigerating compressors, auxiliaries and in the bottling plant. The 30 lb. extraction steam is used for process requirements in the brewery. Water for the steam and refrigerating condensers is cooled by an 11 cell forced draft tower on the roof with a total cooling capacity of 12,900 g.p.m. The 10 ft. dia. fans in each cell are each V-belted to a 20 hp. Westinghouse motor.

New brew house and the new boiler room operate on alternating current and the four 300 t. ammonia compressors to be installed will each be powered by a 400 hp. synchronous motor. A portion of the brewery, including the charging of 125 electric trucks, still operates on direct current. This necessitated the installation of three synchronous motor generator sets and these synchronous motors provide power factor

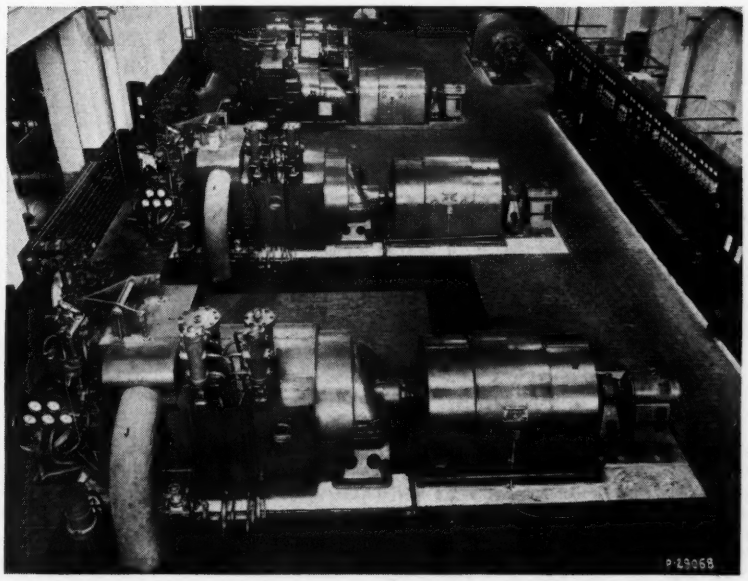


Fig. 1. General view of turbine room. The two units in the foreground are each 2000 kw., 2500 kv-a. double bleeder machines with throttle steam conditions of 400 lb., 600 deg. F., bleeding at 110 and at 28 lb. and exhausting to 28 in. vacuum. Beyond is the 1000 kw. turbine generator and the three m.g. sets. The main control board is also located in the turbine room

correction sufficient to maintain the system at a point near unity.

These sets are rated at 500, 300 and 200 kw. respectively and can be operated to follow the load efficiently. Reliability is also afforded as any two sets can carry the load under most conditions.

Electrical System

The entire electrical system has been planned to insure uninterrupted operation. There are two separate bus systems connected by Westinghouse 1000 kw. bus tie Inerteen transformers, 3 ph. 2200/220 v. These transformers can be completely isolated by their high and low tension circuit breakers so that a transformer fault will not affect the operation of the system. Further insurance to uninterrupted operation is gained by having the 1000 kw. turbo-generator on the low tension bus while the two-2000 kw. alternators, generate at the high tension and feed the 2200 v. bus. This failure of either bus or the bus tie transformers cannot cause complete failure of electric service.

The low tension switching is done by Westinghouse carbon circuit breakers mounted on vertical panels of ebony asbestos and provided with disconnect switches.

High tension switchgear is of vertical lift up, cubicle type. Individual breakers are removable for inspection and can be replaced by a spare, or by any breaker in the switchgear—of equal rating. High interrupting capacity is provided with circuit breakers utilizing De-ion arc extinguishers.

The main control board for all switchgear is located on the turbine room floor and consists of a row of steel panels on which are located all metering instruments, all protective relays, control switches, voltage regulators and other items necessary to proper operations of such a station. An interesting feature of this board is a Westinghouse automatic synchronizer which automatically closes the incoming breaker when a machine is being paralleled. This device makes it impossible for an operator to bring a machine in out of phase, because the synchronizer selects an instant when speed and phase relation are right and then closes the incoming breaker.

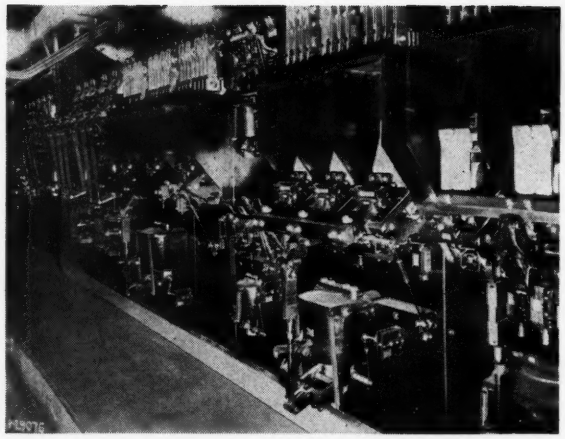


Fig. 3. Switchboard for 125 v. d.c. and 220 v. a.c. The former is used for control of the three m.g. sets, the latter for the m.g. motors and for plant feeder lines

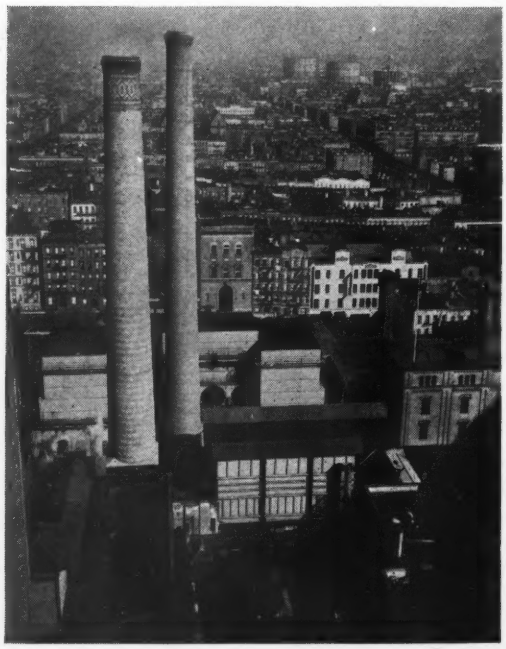


Fig. 2. View of New York City and the Jacob Ruppert Brewery as seen from the roof of the 13 story beer storage building. The stack at left served the former boiler house, the one at right serves the new power plant. In back of the stack is the forced draft, cooling tower. Just in front and to right of the stacks are the ash collectors and the coal bunker. The boiler room and turbine room are below and in back of coal storage building

Synchronous Condenser Runs at High Speed

One of the most interesting rotating machines designed in the last year by Westinghouse is a 25,000-kv-a, hydrogen-cooled synchronous condenser, departing radically from the customary in several respects. Synchronous condensers traditionally have been slow-speed machines—usually 720 or 900 r.pm. This one runs at 3600 and is the first condenser to use the turbo-type construction common to the high-speed generators. The higher speed makes for desirable decreases in rotor weight.

Excitation for this condenser is supplied by an ignitron rectifier instead of the usual rotating direct-current generator. The rectifier output voltage to the condenser is regulated by a new form of electronic voltage regulator, which, with rectifier excitation, brings to the installation the advantages that attend an excitation system without rotating parts or brushes. In addition, a higher speed response—helpful to stability during transient conditions—is obtainable inherently from electronically controlled, ignitron-supplied excitation. As changes in exciting current are made through electronic devices that have but little electrical inertia, their response is virtually instantaneous. Thus, it is possible during system disturbances to overexcite the condenser, producing high momentary overloads, making for system stability.

With a registered attendance of well over 2000 the Seventh Annual Convention of the Edison Electric Institute held in New York City June 6 to 8, was the largest of any since the formation of the Institute in 1933.

Electric Utility Executives Go To World's Fair

FOR ONE DAY, at least, the electric utility executives who attended the Edison Electric Institute Convention in New York divested themselves of their business worries and spent a carefree day at the New York World's Fair. And, judging from the enthusiasm which they displayed and the interest they took in the exhibits, it was a day well spent; one from which they probably derived more real benefit than from the more or less stereotyped business sessions at the Waldorf-Astoria. The business sessions on the whole were quite passive; there was some resentment regarding government policies with respect to the electric utility business but this was very general and on the whole the utility business was good—much better, in fact, than that of many other industries. As President Kellogg pointed out in his opening address, while the index of industrial sales countrywide in 1938 was 17 per cent below the previous year, the electric utilities showed for the same period a decrease in gross revenues of only 6/10 of one per cent. This, however, was less satisfactory than the figures implied, said Mr. Kellogg, because increased labor costs and taxes had brought about a decrease in net income of 6 per cent from 1937. While the 1939 earnings have recovered almost to the 1937 levels, the percentage of net income is still far below its levels ten years ago.

This, Seventh Annual Convention of the Institute, was quite short. The general sessions were held at the Waldorf-Astoria Hotel on Tuesday, Wednesday and Thursday morning during the week of June 5. The only afternoon session held was that held at the World's Fair on Tuesday afternoon. These arrangements gave the visiting members ample opportunity to visit the World's Fair, which, after all, was the primary reason the convention was held in New York this year.

The total registered attendance was well over 2000, the largest attendance in the history of the Institute.

It was quite fitting thta this convention be so closely associated with the World's Fair. Certainly no industry is more involved in making the World's Fair the wonderful spectacle that it is. Without the extraordinary illumination, without the myriad ways of applying the force of electricity not only in the electrical exhibits but in all the other divisions of the exposition, there could be no such thing as the New York World's Fair. The electrical industry's achievements are interwoven into every element of the Fair from the illumination of the Perisphere to Billy Rose's Aquacade.

It was, therefore, appropriate that the Edison Electric Institute come to New York city for its convention this year. The Fair is both an inspiration and a challenge to the electrical industry. It provides a glimpse of a world of tomorrow where scientific advancement is applied intelligently to improve social conditions but which must rest firmly upon an electrical foundation. Dominantly electrical as the exposition is, it should instill confidence in the future of the industry and broaden the outlook of the individual.

Although some committee meetings were held on Monday, the convention opened formally on Tuesday morning with an address by the president of the Institute, C. W. Kellogg, in which he presented a brief but concise picture of the status of the industry. His remarks concerning the relative standing of the electric utility industry as compared with industry in general have already been alluded to.

Discussing the industry's relations with the government, Mr. Kellogg said:

Fluorescent lamps, a contribution of the electrical industry, make a unique figure in the General Motors Exhibit. (Photo, Westinghouse)

Powerful searchlights form canopy of light over court of peace. From the tops of the Halls of Nations 16 searchlights using 1000 watt Westinghouse water cooled mercury lamps send their powerful beams upwards

"The curious spectacle continues of attack by the Federal Government on the investment of its citizens in the electric utility business, even to the point of spending huge sums of money collected from the taxpayers to duplicate private investment. In the Pacific Northwest, where the degree of electrical development has for many years been far above the national average, the private utilities have developed a very complete network of high tension transmission lines, feeding into correspondingly complete distribution systems, carrying electricity to every nook and cranny of the area. The logical procedure in bringing the output of the government plant at Bonneville on the Columbia River to the only market which could absorb it would be to feed into this existing network. This could be done for an estimated construction cost of $15,000,000. Instead, we find the government launched on a program to spend, eventually, $75,000,000 for additional transmission lines, $60,000,000 of which is pure duplication of existing facilities."

He pointed to the TVA and to PWA loans and grants for non-federal power purposes as further evidence of the subsidized competition which the industry is obliged to meet.

The alleged power shortage, Mr. Kellogg thought largely mythical. Throughout the entire 57 years of the industry's history, except in a few local instances, the industry has been able to supply all the electricity for which it could find a market, and a large part of its effort has been directed toward trying to create new and larger markets.

With respect to America's power supply in case of war, Mr. Kellogg pointed out that the generating capacity in America at the end of this year will be four times what it was at the end of 1917. The total annual electrical energy supply in this country at the present time, including the production of generating plants in manufacturing establishments, has reached about 140 billion kw-hr., and the present generating capacity could supply 40 or 50 billion kw-hr. additional, assuming the factories working longer hours, according to war time schedules.

As compared with this, Mr. Kellogg pointed out, the entire industrial energy consumption of the United States in 1917 supplied by both central stations and the generating capacity in manufacturing establishments, was about 23 billion kw-hr. From this, Mr. Kellogg implied that we were vastly better prepared to supply our war time power needs today than we were in 1917.

Concluding his address on a note of "moderate optimism" as he put it, Mr. Kellogg also issued a warning. "It is encouraging to find ourselves no worse off than we are after six years of attack by the government. We must never forget, however, that, more important than all for our future welfare is what our twenty-seven million customers think about us and about the sort of job we have done in the public service. During all these years that the public has had to face so many pressing problems of its own that we cannot ask or expect from them special sympathy with us in our specific troubles. They will size us up solely on the efficiency and dependability of our service and on the way we conduct ourselves in our daily relations with them. It is the degree to which we have satisfied our service obligations that has brought us to the present day still a strong stable industry. Our salvation is largely in our own hands. With our past achievements and with the resolve to do even better in the future I believe we can and will do better in the future."

What to Expect of Real Estate

One of the most interesting papers presented at the general sessions was that by Roy Wenzlick of Real Estate Analyst, Inc., of St. Louis, Mo. Curiously enough Mr. Wenzlick's subject was not one directly concerned with any aspect of the utility business. It embodied a critical analysis of real estate values and building and renting operations over a period which covered the entire life of the United States government. By means of comprehensive charts stretched across the entire width of the stage Mr. Wenzlick portrayed in a striking graphic manner the recurrent swings of real estate values over the 170-yr. period of the country's history. These charts indicated very conclusively that real estate values fluctuated in an astonishingly regular manner and that the average cycle between peaks had a period of 18.4 yr. In all this time the interval between peaks had never been less than 16 yr. nor longer than 20. Coincident with the curve showing the real estate value fluctuations, Mr. Wenzlick also depicted the fluctuations of general business operations over the same period. This much was history. The primary purpose of the analysis was to show that we are now about to experience another upswing in real estate values. We have just passed the transition point from a depression to a boom period and we are now in the early stages of a boom

What is a Kilowatthour

1. A kilowatthour is work—work equalling 35 trips up the Washington Monument.

2. No man can make a kilowatthour in a day with his muscles alone.

3. One kilowatthour is always more work than any man can do in a day.

4. The average power which a man can exert all day is 35 watts.

5. For the cost of one cigarette, a family can obtain perfect refrigeration for five hours with a good machine.

C. M. Ripley.

swing. This real estate building boom according to Mr. Wenzlick's analysis will rise very slowly during the next year or two but if history is any criterion it should rise to its peak about 1943.

Naturally this prediction, if accurate, is of greatest importance to the utility industry since an increase in building and real estate values inevitably will be reflected in an increase in utility business. As Mr. Floyd Carlisle who followed Mr. Wenzlick as a speaker remarked, he only *hoped* that Mr. Wenzlick's predictions would come true. On the whole it was a very stimulating and encouraging event in an otherwise uneventful meeting.

Floyd Carlisle in welcoming the members of the convention to New York on behalf of the Consolidated Edison Company of New York expressed his confidence in the future of the electrical industry on the basis of the confidence which American private ownership had expressed so overwhelmingly at the Fair. One hundred and fifty-five million dollars, Mr. Carlisle pointed out, had been expended to put on a magnificent international exhibition at a time of great depression to show the American economy to the whole world.

The Fair to him was the newest way to expressing ideas. He said that he wished that every citizen in the United States could attend the Fair and see with his own eyes this dramatic presentation of our economic order. It it not in speeches but in beautiful buildings and dioramas, in pictures and animated turntables, in pageants, in blank verse, in music that American business is telling its story at this exposition. In discussing the outlook for the electric utilities, Mr. Carlisle pointed out that it is dangerous for anyone to be dogmatic. The electrical industry, he said, was one of the few leading industries in this country, that had increased its output during the depression and that it was so interwoven with the life and work of the nation that it could not permanently prosper except as the country as a whole prospered. The industry he said, was started a little over 50 yr. ago simply with an idea but in that time has become one of the largest industries in this country. It was built up by men of great inventive genius with capacity to meet and adapt themselves to progressive changes. There have been far more difficult times in the past for the industry than exists today. In New York, he said, that it had been found possible to increase the sale of appliances on a scale greater than before the depression. If all the industries of the United States had the ability to expand their services as the electrical industry has done there would be no depression and no unemployment.

Television, by Major Lohr

The final address on the Tuesday morning program was one on the present status of television by Lennox Lohr, president of the National Broadcasting Company. Mr. Lohr spoke briefly of the history of television, of the early attempts and of the great difference between present day electronic methods and the previously used mechanical systems. There were, he said, three aspects to television, the first, technical; the second having to do with program arrangement, and the third commercial. Although the technical aspects had been of incredible difficulty their solution had been achieved with a much higher degree of success than that of the program and commercial aspects. Present day electronic systems give a very well defined, if somewhat small, picture. The program aspect, he pointed out, had not been solved at all and is still in the experimental stage. The program aspects are related to the commercial aspects since a satisfactory solution to the program problem it seems, could only be arrived at by the expenditure of great amounts of money. At the present time, Mr. Lohr said, a single hour's daily broadcast would cost approximately a million dollars a year. This great cost, he pointed out, made it vitally important that the proper type of program be worked out before sponsors could be obtained who would be willing to spend that amount of money. At the present time, Mr. Lohr said, regular television programs are being broadcast from the Empire State transmitter of the National Broadcasting Company and receivers varying in price between $150.00 and $600.00 are available in the metropolitan area of New York. Until a method is developed whereby television programs can be sent over wires or by radio to other places television will be available only in the very largest cities. Just within the past few weeks he said they had been successful in transmitting a television program over telephone wires. While this would not necessarily solve the difficulties for transmission over long distances, it considerably simplified the technic of picking up programs from points outside the main studio. A great deal of research is going on and Mr. Lohr was quite optimistic about the possibility of transmitting programs from New York to other important American centers. The cost of television programs is so great that some means must be found for sending them to other cities for local distribution.

At the World's Fair

The Tuesday afternoon session was held in the Music Hall at the World's Fair with James E. Davidson, vice-president of the Institute, presiding. Grover Whalen, president of the Fair, extended official greetings and spoke of the importance of the many exhibits which the Fair presented as indicative of the progress which has come to us in this country. Floyd Carlisle described the exhibit which his company, The Consolidated Edison Company of New York is presenting at the Fair with particular emphasis on the City of Light. This great diorama, he explained, was conceived to give those who see it an understanding of the part which electric service plays in the development and activity of the modern city. Mr. Carlisle's address was followed by one by Owen D. Young of the General Electric Co., who was scheduled to outline the features of the General Electric Company's exhibit at the *Fair*. Mr. Young, however, in his customary graceful way gave that honor to the man whom he said had been responsible for the details of the exhibit. This man he described as the youngest member in their organization, Charlie Appleton. Mr. Appleton, who happens to be a G. E. veteran of may years standing, graciously accepted Mr. Young's compliment and then went on to explain how in the early stages they had conceived the idea of bringing the ten million volt lightning generator from Pittsfield down to the Fair so that the public could see what science had been able to accomplish in the control of lightning.

Welcome to the Westinghouse Electric and Manufacturing Company's exhibit was extended by D. S. Youngholm, vice-president. Mr. Youngholm stressed particularly the part which electricity played throughout the Fair, especially in the modern lighting effects. A significant contribution of his company, he said, was

.....The United States is now in the intermediate period between a real estate depression and the next boom. Activity in real estate and construction varies in a cycle which is quite different from general business. This cycle is characterized by its extreme length, 18.4 years. In all the time since 1795 the period between peaks has never been shorter than 16 years nor longer than 20 years. We have now emerged from a period of long depression and are about to enter on the next boom period, which should reach its peak around 1943.

Roy Wenzlick.

in the Junior Hall of Science where boys and girls of high school age are given an opportunity to work in a real labortaory.

The final speaker was A. H. Schoellkopf, of the Niagara Hudson Power Corporation and chairman of the Electric Utilities Exhibits Corp. The exhibit which is called the Forward March of America with its street of yesterday and avenue of today is sponsored by a large group of public utilities of this country. These exhibits, Mr. Schoellkopf said, were designed to demonstrate the part played by electricity in the country's development through the past fifty years. Following the meeting in the Music Hall guided tours to the various electrical exhibits were arranged for the members and their guests.

The Importance of Nickels

In recounting the Progress in Rural Load Building by the Utilities in recent years, H. E. Dexter, vice-president of the Central Hudson Gas and Electric Corp., pointed out the influence of low cost appliances and the use of meters that take nickels. The gambling business, he said, takes 10 to 15 billion nickels per year out of nickel machines. Nickels are small change—everybody is careless with them; why not capitalize on this fad? Mr. Dexter demonstrated a complete low cost electric kitchen equipment which was being sold in the territory served by his company at a cost of two nickels a day and the customers liked the idea. This kitchen consisted of a roaster-broiler-top burner combination costing $36.50; an electric teakettle costing $6.95 and an electric refrigerator costing $77.95; a total cost of $121.40 for the three appliances.

As an indication of the possibility of meter selling, Mr. Dexter said that today, in their third year of meter selling, they were picking 250,000 nickels per month, or approximately 3,000,000 nickels per year from meters.

As a consequence of these and other practices employed by Mr. Dexter's company in selling rural service, he said that in 1938, the kilowatt hour sales to farms was 13 per cent over that of 1937, and farm incomes were down. The figure at the end of the year was 1769 kw-hr. per farm customer against the national average for non-irrigated farms of 1045. The average price per kw-hr. to the farmer was 3.71 cents against the national average of 4.5 cents per kw-hr. But the "take" per farm for electricity was $65.72 against a national average of $47.03.

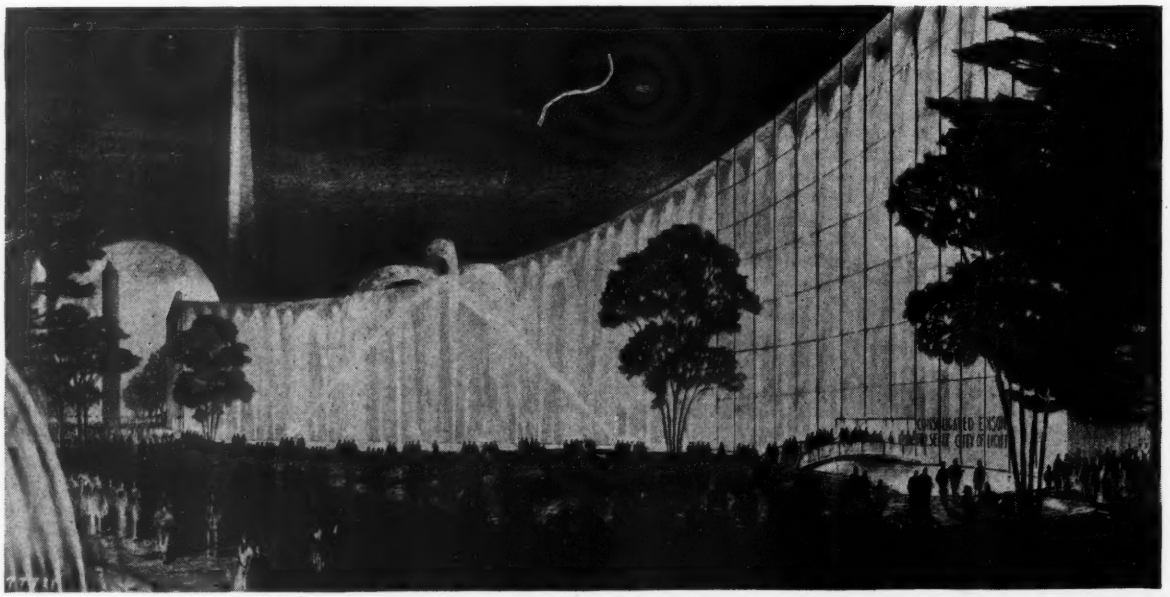
Mr. Dexter's paper, which was presented on Wednesday morning was followed by three others, one on "War Procurement and Electric Power" by General Charles Keller of the Public Service and Engineering Corporation of Chicago, another on "Balanced Load Building" by George E. Whitwell of the Philadelphia Electric Co. and the third, entitled "A Kilowatthour" by C. M. Ripley.

Mr. Ripley's address was extremely thought-provoking since he discussed the meaning of the term kilowatthour in terms of work. His theme was that "when you buy electricity you buy work." One kilowatthour, he pointed out was equal to 35 trips up the Washington monument. Another point he emphasized was that no man can make a kilowatthour in a day with his muscles alone. The average power which a man can exert all day, Mr. Ripley said, was only 35 watts.

Next, he disclosed the quite startling fact that for the cost of one cigarette, a family can obtain perfect refrigeration for five hours in a good machine. And still more startling was the fact that $10.00 buys from 24 to 38 times as much electricity as $1.00 buys.

The third session on Thursday morning was given over largely to the presentation of awards but the program included two papers, one "What the Customer Thinks of Utilities" by Elmo Roper, and the other "The Case for Central Station Power" by H. M. Sawyer of the American Gas and Electric Co. With public opinion changing faster than ever these days, and with intensive efforts to shape public opinion this way or that by pressure groups of every complexion, Mr. Roper's address was of considerable importance. As a result of surveys made, he pointed out that the good public relations work done by the utilities in recent years had had its effect and the public is friendlier to the utilities than it was some time ago.

In presenting the case for the utilities, Mr. Sawyer felt that the basic facts did not justify the alarm and apprehension that prevailed throughout the industry as a whole. He preferred to view present trends and policies, as a detail of the complete picture rather than as individual and isolated problems in themselves. His discussion analyzed in detail the selling points of the electric utility industry in comparison with the selling aspects of various competitive isolated power sources. Needless to say he felt that the utilities could face the future with reassurance and that the same spirit which had enabled it to survive and develop under the keenly competitive conditions of the past would carry it on in the future. In speaking of Diesel competition, he said that in all fairness, however, this type of prime mover might well have a definite place in the national picture.



"Water ballet" facade for the exposition building of the Consolidated Edison Co. The building's entire 9000 sq. ft. facade is sculptured in water by a fountain colonnade formed by the discharge of 40,000 gal. of water an hour to a height of 42 ft.

S. P. A. Meets In Milwaukee

Thirty-third Annual Convention of the Smoke Prevention Association, June 13 to 16, reviews political, civic and technical problems and plans for the future

WHILE LABOR TROUBLES in Milwaukee held the National spotlight, the Smoke Prevention Association proceeded with a quiet and serious consideration of its own problems, a reduction in the annual property and health damage which it is estimated runs up as high as 10 million dollars for a single American city the size of Milwaukee. Significant of the progress that has been made and plans for the future was the underlying theme of the convention, that smoke can no longer be measured solely by the Ringlemann chart but that the definition must be broadened so as to include all dust, noxious and poisonous products of combustion.

The topic appeared in the program but once, J. F. Barkley's paper on reducing flyash emission from chimneys but it cropped up continually in discussion, and seems destined to play an increasingly important part in the future. Where black smoke is still a problem, the lesser evil of dust and fumes remains hidden but in communities where definite progress has been made in black smoke control and prevention, the dust problem is already being taken seriously.

Municipal Ordnances

Cincinnati has just finished drafting a municipal ordinance which, however, has not yet been passed. The significant parts of this proposed ordinance were reviewed by Chas. W. Gruber, Chief Smoke Inspector, in his paper, "Requirements that should be incorporated in a Smoke Ordinance." Among other features of the proposed ordinance is a maximum limit of 400 gr. per thousand cubic feet of 500 deg. F. gas. This is comparable to allowable dust loadings of from 200 to 350 gr. for other cities of the United States and Europe.

All seem convinced that definite legislation is a necessary pre-requisite to effective smoke prevention but those that had experience agree that the court is a poor enforcer and less effective than friendly cooperation with the offending owners and operators. Cincinnati has had considerable success by enlisting the cooperation of coal dealers. A copy of the violation notice sent the owner of the plant is also mailed to the coal dealer.

The health and civic features are of course the most important phase of smoke prevention and occupied an important part of the program from the opening address of President William Culbert, Chief Smoke Inspector of Nashville. This part of the work was touched upon by David W. Hoan, Mayor of Milwaukee, Roy O. Johnson of the Indianapolis Smoke Abatement League and Dr. John P. Koehler, Health Commissioner of Milwaukee. Dr. Koehler went so far as to advocate, among other things, a tax of $1 a ton on smoke producing fuels.

Technically the means of smokeless operation are available and President Culbert said, "People can live in smokeless cities any time they want to . . . when they take advantage of smokeless fuels, furnaces and equipment now available." Practically he was perhaps a little optimistic, certainly more optimistic than the report of Ralph A. Sherman and R. C. Cross of the Battelle Memorial Institute justified.

Combustion Space

This report, made for stoker, coal and boiler interests, dealt with a combustion space survey made on some 100 boiler installations of all sizes. The results showed no relation between smoke and unit heat release and little relation between smoke and setting height. While the investigation is subject to certain limitations due to the small number of plants investigated, the start made offers possibilities of leading to worth while results when more fully developed.

The conclusion of the report, as to the effect of combustion space, was confirmed by the paper of Wm. A. Pearl, Professor of Mechanical Engineering at Armour Institute, on Properties of Coal that Affect Burning Characteristics. From a background of many years research Professor Pearl stated that smoke formation is not a matter of volatile matter, furnace volume or ultimate analysis but an individual characteristic of the coal which depends upon the way the hydrocarbons break up when heated. Some coals can be burned smokelessly, some cannot and the way to find out is simple —just try some in your furnace.

Stoker Operation

For those that must do just this, E. C. Webb, Engineering Service Manager of the Iron Fireman Mfg. Co. had some practical suggestions in his paper Conditions that Influence the Production of Smoke and Flyash Nuisance in the Operation of Underfeed Stokers. He said that smokeless operation was a matter of: the coal; design of the boiler and furnace; design of the stoker and auxiliaries; installation; operation; and maintenance. Lack of attention to any one or several of these factors may lead to difficulties which are often difficult for the service man to isolate and correct.

Ben G. Elliott, Professor of Mechanical Engineering, University of Wisconsin, had a very definite solution for the whole problem and said, "I look forward to the not too distant day when heat will be supplied from a central source. That will, of course, solve the smoke problem." Trends in this direction in connection with the new housing projects in all parts of the country were pointed out by Frank A. Chambers, Secretary-Treasurer of the Association and Chief Smoke Inspector of Chicago.

Practically, of course, fuel burning equipment is only part of the problem. There are fuels and fuels, some good and some bad, but all of which it is desirable to use to a certain extent in different parts of the country. Some of the less desirable fuels can be improved by preparation or processing so as to reduce the volatile or smoke producing content. The Illinois State Geological Survey has been active in this work for many years and a comprehensive research program which is contemplated, if money is available, was outlined by M. M. Leighton.

Rapid increases in the use of cleaned or processed coals have left large quantities of fine coal difficult to use. C. E. Lesher, president of the Pittsburgh Coal Carbonization Co. described the development and commercial application of a carbonization process for producing a desirable smokeless fuel from these fines. The product known as Disco is at present available in limited quantities and sells at a price competitive with high temperature coke. The process is applicable to most coals, however, and under favorable conditions may be produced and marketed at a cost comparable to the better grades of prepared coal from the same fields.

The extent to which flyash from coal is influencing new plant design was illustrated by the paper of J. F. Barclay mentioned earlier. After outlining some of the problems connected with the identification of, and testing for, flyash he gave a comprehensive review of the equipment available for flyash elimination. Most of these were shown installed in typical plants and ranged from simple homemade devices effective only on large particles to elaborate commercial equipment intended to eliminate the fines.

Officers

At the final session on Friday morning St. Louis, Mo., was selected as the 1940 Convention city and the following officers were elected: President, Reinhard E. Kunz, Chief Examiner, Supt. of Inspections, Milwaukee, Wis.; first vice president, George Richey, Chesapeake & Ohio R. R., Richmond, Va.; second vice president, John Benschip, Chief Smoke Inspector, Pennsylvania R. R., Chicago, Ill.; secretary-treasurer, Frank A. Chambers, Chief Smoke Inspector, Chicago, Ill.; Sergeant at Arms, Paul Miller, Illinois Northern R. R., Chicago, Ill. As an added feature to the banquet entertainment, Charles W. Poethke of Milwaukee was honored as the originator of and only living charter member of the association. The first convention was held in Detroit and was attended by about a dozen smoke inspectors from different cities. At the time Mr. Poethke was smoke inspector at Milwaukee and is still active in the department in spite of his 76 yr.

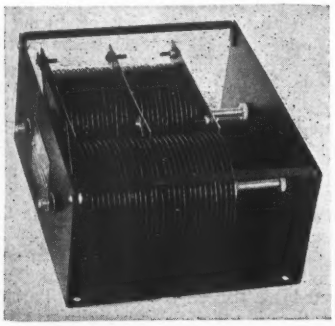
New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Copper Oxide Rectifier

A NEW TYPE copper-oxide rectifier for oil circuit breaker operation is announced by General Electric Co. Rated 50 amp., 120 v. d-c., 220 v. a-c, for two cycle operation not exceeding four per minute, the new unit has been developed to supersede the former 3-amp. unit, or multiple combinations of such units.

With its 50-amp. rating, one of the new rectifiers can replace 16 or 17 units of the previous design. It requires less



space and eliminates possibility of trouble due to improper balancing or dividing of current through numerous parallel paths.

A lower working potential of 16.4 v., as compared with 22 v. in the old design, is obtained by using 14 oxide washers in each leg of the new rectifier instead of the ten previously used. This gives a 40 per cent increased factor of safety in each leg.

Washers of the new rectifier are coated with metallic conducting material of the oxide, and held together in good contact with about 300 lb. pressure. The disk assembly is sealed against atmospheric conditions and is moisture-and corrosive-gas proof.

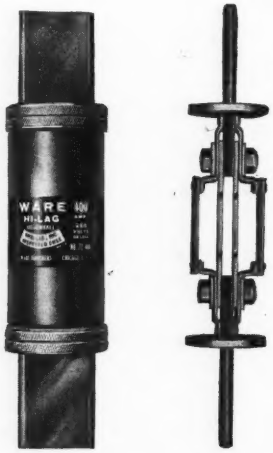
The new unit is mounted in a perforated metal case and is approximately one-third smaller than the old-type unit.

Hi-Lag Fuses

A NEW line of renewable fuses are being manufactured by Ware Brothers, 4500 W. Lake St., Chicago, Ill., which have a number of unusual and desirable features. These fuses, which are fully approved by the Underwriters in all sizes for both 250 and 600 v., from 3 to 600 amp. are rugged and simple in design and have high electrical qualities.

The particular feature which the manufacturers emphasize is the fact that while these Hi-Lag fuses protect the circuit strictly in accordance with the requirements of the Underwriters' Laboratories, they have a high-lag feature whereby they will absorb momentary surges, overloads, occurring during the starting of some types of motors, thereby preventing needless blowouts, while still protecting the circuit against prolonged overloads or short circuits.

These fuses have a long electrical path and can, therefore, generate the heat required to blow the fuse at a predetermined current with more metal in the link; as a consequence more time is required to blow. Most of the heat is generated in the tranverse section near the end where it is absorbed for a time by the copper or brass connecting elements.

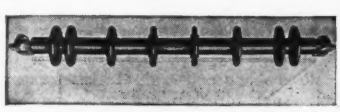


This heat being conducted from the link at two points increases the time lag. Finally, the sections at the center of the link being out of the electrical path are used only to absorb heat.

Hi-Lag links it is claimed can expand and contract freely and the movement is taken up in the transverse sections with very little bending. They are said not to develop high resistance, and have spring tension contacts which eliminate the chance of faulty contacts. They are provided either in the ferrule or knife blade type.

Return Idler

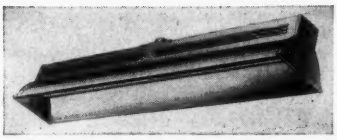
ROBINS CONVEYING BELT CO., New York, N. Y., announces the Rubberdisc return idler which is ideal for use on any conveyor belt which handles abrasive, corrosive, damp, or somewhat sticky material. It is constructed of a steel tube shaft on which are mounted a series of tough and resilient rubber discs, spaced about 6 in. apart except at the ends where the last two are about 3 in. apart. Within the steel tube there are mounted ball bearings, requiring no greasing or oiling and completely sealed against the entrance of grit or moisture. The resilient and flexible rubber discs and the open construction with the belt supported at only a few points instead of its whole width, makes this a self-cleaning idler. The slight deflection of the belt over the rubber discs and the slight deformation of the discs at the point of contact with the belt gives the idler an effective belt cleaning action.



New Fluorescent Lamp Units

THESE new unit-section-reflector type, single-tube Fluorescent lamp fixtures have been especially designed for easy and practicable attachment end-to-end or side-by-side to make it possible to build up from a number of basic unit-sections almost any size and shape of composite, multiple-lamp fixtures to light large surfaces of inspection and assembly tables, as well as, long production lines.

Moreover, each single lamp, unit-section reflector is a self-contained fixture in itself and is particularly designed with the correct type of light distribution for the numerous industrial locations requiring only a single lamp fixture.



Benjamin "Flur-O-Line" units represent a distinct advancement in lighting efficiency over the ordinary wire strip type of Fluorescent lamp assembly. They are based fundamentally on a reflector of scientific design, rigidly maintained to an accurate contour and provided with the correct type of reflecting surface to insure positive light control and maximum output. With this basic reflector design is incorporated a unique, detachable wiring-channel which houses auxiliaries, conceals the wiring and with the various accessory fittings available makes possible end-to-end or side-by-side attachment.

Benjamin "Flur-O-Line" units have reflectors of satin-finish, polished Alzak aluminum. Cast aluminum end plates give added rigidity to reflector assembly and prevent sagging or distortion when unit-sections are ganged together. "Flur-O-Line" units are available for 18, 24 and 36-inch lamps and can be supplied with or without auxiliaries. Benjamin Elec. Mfg. Co., Des Plaines, Ill.

Find out the why of

EDWARD PISTON CHECK VALVES

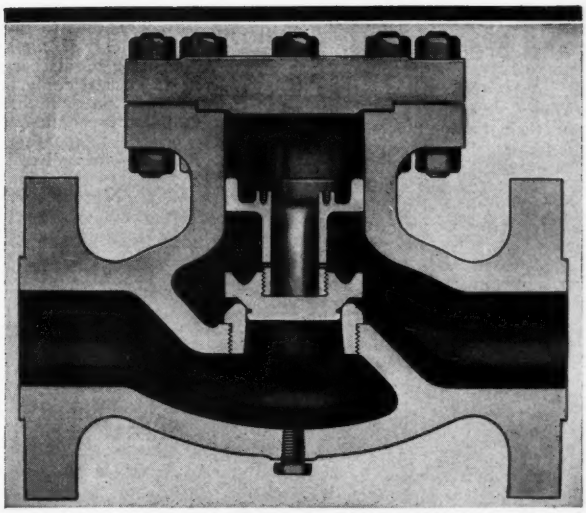
Edward piston check valves do their important jobs quietly and efficiently. Their cushioning action provides the simplest and most effective means of avoiding shock, slam and clatter. It was the happy analysis of a tough problem that led Edward years ago to pick the lift check—with emphasis on the piston—for high pressure service.

NEW DESIGNS STILL BETTER. Numerous changes in design detail have been completed during recent months, to the lasting betterment of the product. These valves should do a better job of taming vicious fluctuations, without excessive loss of head, than any other type. Accurately guided, but with sufficient clearance to avoid jamming or sticking, these valves respond immediately to reversal of flow. Gravity drives the sturdy disk-piston assembly to its seat, just slow enough to avoid jar.

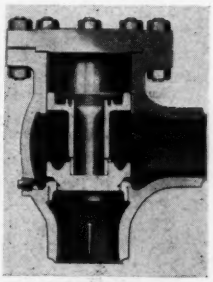
MATERIALS ALWAYS COUNT. Selection of materials for check valves, always an important question, has been given renewed attention. All parts are made under the watchful eyes of laboratory and shop inspectors. Most parts are identical with those used in the Edward non-return valves, with which Edward's reputation is definitely associated. If you have a particularly puzzling return flow problem, you might let us know the details. In some cases the addition of EValloy piston rings to standard Edward check valves has proved helpful.

THE EDWARD VALVE & MFG. CO., INC
EAST CHICAGO INDIANA

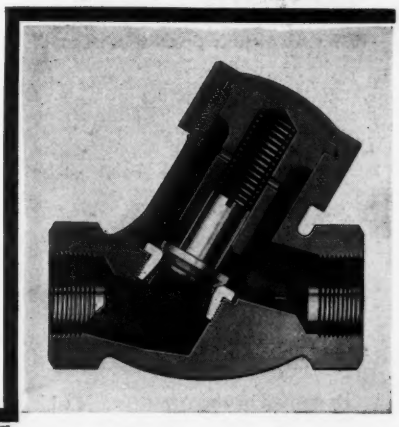
FOR SOME USES, BALL CHECKS. For viscous fluids the piston design may be out. Ball checks usually provide a desirable substitute when the fluid serves to damp the jar of reverse flow. Shown is Edward Fig. 2672, which is particularly popular in oil refineries and process plants.

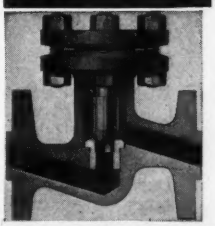


THEY CAN'T SLAM. These two cuts (flanged ends above, welding ends right) show typical construction in sizes 2½" and up. Full provision has been made to provide positive action, freedom from chatter or jar, and no undue restriction of flow. Edward details have been worked out so as to cushion action, provide tight closure, and avoid wear by erosion or abrasion. Three types—horizontal, vertical and angle.



PRECISION GUIDES. In cast valves — steel and Ferac metal (iron) guidance is given by three relatively narrow ribs which keep the disk always centered, but give no lodgment for foreign matter. The disk can go nowhere but home. Bearing surfaces are adequate to prevent wear of moving parts.





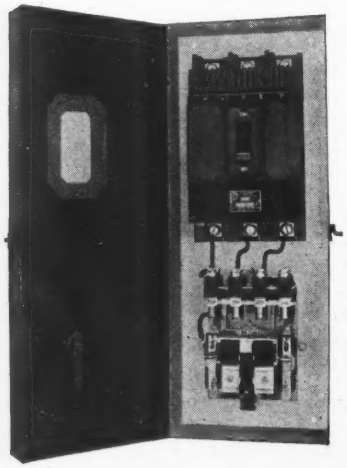
FORGED STEEL VALVES. Small valves (left and above) follow same basic principles with certain modifications due to needs of space. Screwed end valves of the "Y" design are particularly useful as they may be installed in horizontal or vertical lines—with the disk travel in a downward direction.

EDWARD VALVES

A-C Motor Starter and Breaker

ALLIS-CHALMERS MFG. Co., Boston Works, announces an improved design of their type AP-7DB combination air motor starter and circuit breaker. The type AP-7DB consists of a standard AP-7 starter unit combined with an enclosed type air circuit breaker mounted in a substantial metal case. The starter unit is suitable for 7½ hp., 550 v. motors or smaller units. The circuit breaker has an interrupting capacity of 5000 r.m.s. amperes in the 220 v. starters and 10,000 r.m.s. amperes in the 440 and 500 v. starters.

The circuit breaker is manually operated and trip free from the handle. It provides short circuit protection while,

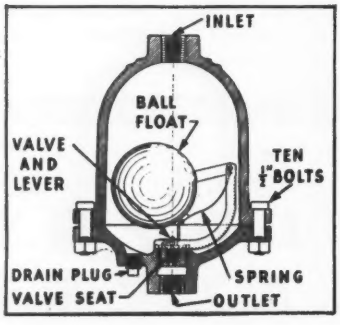


at the same time serving as a motor circuit switch. The use of the air circuit breaker is especially desirable in locations where frequent overloads would otherwise necesitate the continual replacement of fuses.

Efficient time delay overload protection is provided by temperature overload relays in the motor starter unit. Adequate provision is made for conduit connections and for locking the cover of the case.

Air Trap

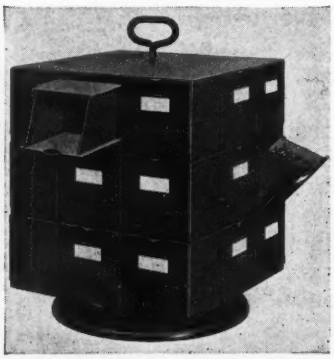
DEVELOPED by the Armstrong Machine Works, 810 Maple St., Three Rivers, Mich., this automatic "snap-action" mechanical trap has the capacity of 1400 lb. of water per hr. at 125 lb. pressure and 1000 lb. per hr. at 250 lb. pressure. The principal advantages claimed for the device are immunity to ordinary dirt troubles, ability to discharge water without any loss of air, positive opening and closing of discharge valve, and freedom from need for priming.



As shown in the cross-section diagram, the trap has a ball float which is connected to the short valve lever through a flat strip of stainless spring steel. In the closed position, this spring is bowed downward. As water enters the body of the trap, the ball float rises—bending and storing up energy in the spring. Just before the ball float reaches the top of the trap, the spring bends past dead-center and the stored-up energy snaps the valve wide open. In this position, the spring is bowed upward. As the water level drops in the trap body, the cycle is reversed and the valve snaps shut.

Steel Bins

MADE by Noggle Products Co., Ann Arbor, Mich., this revolving assembly of welded steel bins is available in a unit containing 24 bins each 3 by 3 by 2½ in. or 24 bins each 4 by 4 by 3 in., all



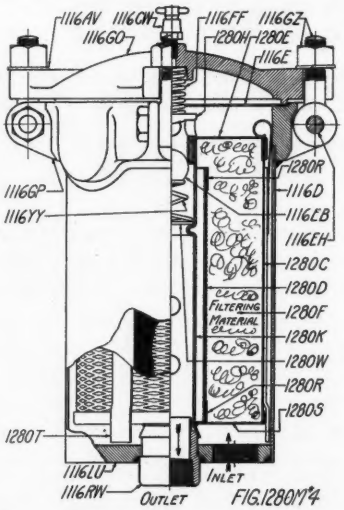
in one compact unit. In either model a double width bin can be substituted for any pair of single width bins. Bins are 26 ga. steel, spot welded and finished in green.

Absorbent Type Filter

FIGURE 1280, the original filter brought out by Wm. W. Nugent & Co., 410 N. Hermitage Ave., Chicago, Ill., in 1935, has been improved by the addition of more filtering surface and a bypass relief valve in the same container or shell, besides being more accessible for the removal and replacement of filtering material (waste, wool, excelsior, asbestos, etc.). All of which is illustrated in the accompanying sectional view Fig. 1280M. The waste cartridge is interchangeable with the bag type filler, Fig. 1116, because the same shell is used with both types.

There are 14 sizes ranging from 5 in. O.D. by 11¼ in. high to 21 in. O.D. by 43 in. high. The capacities when filtering 300 SUS viscosity mineral lubricating oil at 100 deg. F. range from approximately ½ to 16 g.p.m. at 20 lb. pressure drop. Working pressure 125 lb. Some models may be had for 250 and 1000 lb. working pressure.

The filtering material (waste) is easily stuffed into the removable lattice metal cage from a carton containing the correct amount, and so labeled on the outside. The dirty waste is easily shaken out of the cage after removing the center strainer core. The cage has a removable cover held in place by three loop springs which also center the cage in the shell,



thus making a positive seat at the bottom outlet of the filter cartridge or cage.

A fixed spring in the cover holds the cartridge tightly on the outlet seat at the bottom of the shell so that the filter may be installed horizontally or on an angle.

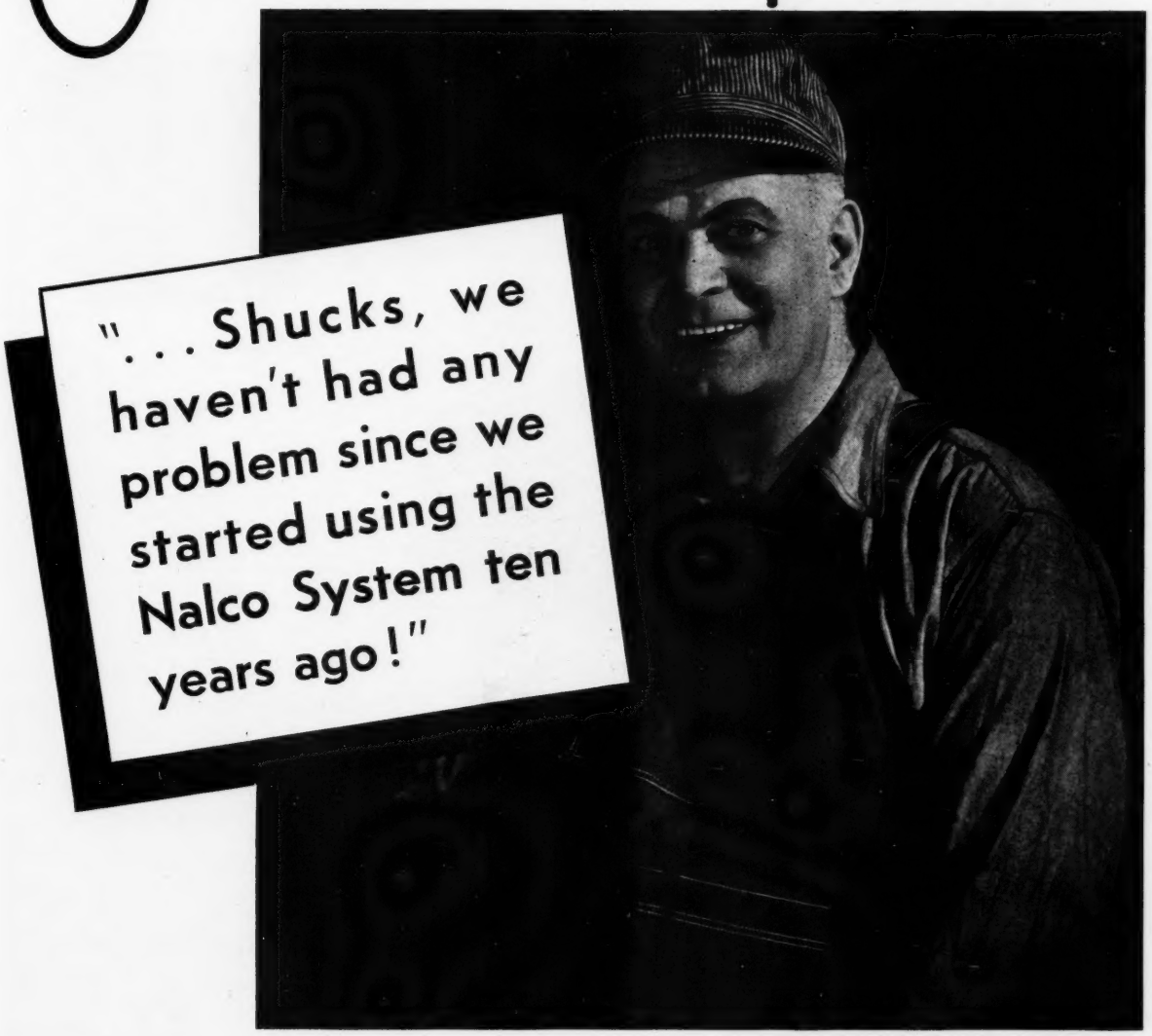
Sander

IN THE FINISHING of mechanical and electrical equipment, the Sterling Speed-Bloc Sander eliminates hand sanding wherever possible to do away with this tedious operation, and is equally effective on metal, wood or composition surfaces. Its unique construction provides complete flexibility for sanding and rubbing concave, convex as well as flat surfaces and in reaching difficult places. The Sterling has been successfully used on such operations as buffing metals, removing grinder and tool scratches and marks, sanding filler and final coats, and polishing.

The Sterling Sander is operated by compressed air, using only 6 cu. ft. per min. at 80 lb. pressure. The stroke travel of the abrasive pad is ⅝ in. at 3000 oscillations per minute. The pad, made of durable rubber and felt, moves back and forth without graining or chasing the surface. Standard-size abrasive sheets of any grit or make, cut into three equal parts, are quickly and easily attached by means of a special-type holder attached to the machine. The Sterling is also fitted with a water connection and can be used for either wet or dry sanding.

The sander measures 7¾ in. long, 4¼ in. high, 3¾ in. wide and weighs but 5½ lb. and is made by the Sterling Products Co. 2457 Woodward Ave., Detroit, Mich.

"Our Feedwater Treating Problem..?"



HUNDREDS of engineers, over 3500 in fact, are finding that it pays to let Nalco do the worrying about boiler water treatment in their plants. We think that you, too, will find that this pays.

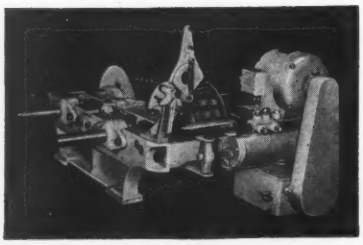
If you are like most of us, you probably have plenty of other problems that you could more profitably spend your time on IF you had the right kind of service on feedwater. We believe we can give you that kind of service. Complete information on request. NATIONAL ALUMINATE CORPORATION, 6224 W. 66th Place, Chicago, Illinois.

THE NALCO SYSTEM OF FEEDWATER TREATMENT

Inquiries other than domestic, *except those from U. S. Possessions, Canada and Mexico,* should be addressed to Alfloc Ltd., Bush House, Aldwych, London, W.C. 2, Eng. Canadian inquiries should be sent to Aluminate Chemicals Ltd., 372 Bay St., Toronto, Ont.

Hydraulic Automatic Control

A NEW and improved type of hydraulic automatic control for use with Reeves Variable Speed Transmission is announced by the Reeves Pulley Co., Columbus, Ind. The control is simple and compact in design and speed change from one extreme to the other can be made in from 6 to 20 sec., depending upon the size and speed ratio. The control lever may be located anywhere on a 360



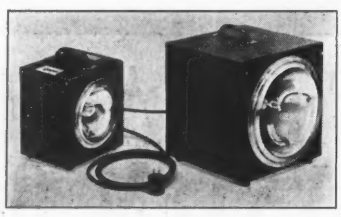
deg. circle to give direct connection to the operating mechanism and as pressures change from 2 to 3 oz., will produce a change in speed.

The control lever moves a two way pilot valve mounted integral with the operating cylinder immediately above the oil reservoir. Hydraulic power for operating the two pairs of shifting levers and controlled by the pilot valve is supplied by a small electrically driven oil pump located in the reservoir.

New Stroboscopes

TWO STROBOSCOPES are announced by General Radio Co., 30 State St., Cambridge, Mass. These are portable units suitable for both speed measurement and slow-motion studies of rotating and reciprocating mechanisms, such as motors, gears, shafts, flywheels, engines, fans, pumps, pulleys, cams, valves, governors, etc.

Speed measurements with an accuracy of ±1 per cent can be made with the new Type 631-B Strobotac which supersedes the older Type 631-A. No mechanical or electrical contact with the machine under measurement is required. The stroboscopic light is directed on the machine



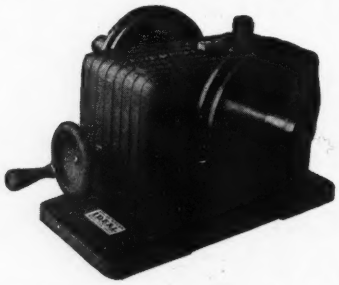
under measurement and the flashing rate adjusted until the motion appears to be stopped. The speed is then read directly from a scale graduated in r.p.m. Speeds between 600 r.p.m. and 14,400 r.p.m. are read directly from the scale, which is conveniently located at the top of the instrument. Small size (7½ by 8¾ by 10 in.) and light weight (10 lb.) are additional features.

The Type 648-A Strobolux is a larger instrument, furnishing about 100 times as much light as the Strobotac. It is used in conjunction with the Strobotac when larger areas are to be illuminated or where background lighting is strong. It can also be used as a light source for single-flash photography. The Strobolux is 13 by 11 by 13 in., overall, and weighs 25 lb.

Both units operate from the a-c line. The Strobotac requires 25 watts, the Strobolux 150 watts.

Variable Speed Transmission

A NEW series of "Select-O-Speed" Transmissions with hand wheel control is being announced by the Ideal Commutator Dresser Co., Sycamore, Illinois. These new models supplement the standard line from fractional to 7½ hp. capacity that are equipped with lever type control. The hand wheel is recommended where finer speed adjustments and smaller increments of speed are necessary. By turning the wheel only a partial turn it is easy to change the speed only a few revolutions per minute.



This type of control is especially desirable for installations requiring remote control. By replacing the hand wheel with a set of beveled gears and extension rod and universal joint, the point of control may be taken to a more convenient location.

Hand wheel control is available on S-O-S Variable Speed Transmissions of sizes from 1½ to 7½ h.p. capacity.

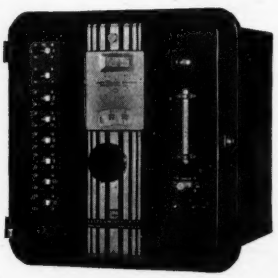
Enamel

FRANZITE is the name given to a new fast air drying 100 per cent synthetic enamel recently released by Hilo Laboratories, 42-60 Stewart Ave., Brooklyn, N. Y. It was specially formulated to give good hiding and high gloss in one coat. The enamel is elastic and has good adhesion to wood, steel and similar surfaces. It will set in 20 minutes, dries to touch in 45 minutes and may be forced dried by 20 minute bake at 150 deg. F.

Temperature Indicator

AMPLE space for toggle-type switches, for connecting any one of a number of couples to the measuring circuit, is provided in a new temperature indicator made by the Leeds and Northrup Co., 4934 Stenton Ave., Philadelphia, Pa. Installed wherever convenient, it enables an operator to measure temperatures of near or distant couples with equal reliability, by simply turning a knob, until a pointer comes to zero, and reading a temperature scale.

Use of a potentiometer measuring circuit . . . hand-standardized, but with automatic reference-junction compensation . . . eliminates uncertainties due to circuit-resistance variables. Scale is practically uniform and equally accurate throughout, and can be calibrated for single or double range, the latter for use with similar or different couples. Built-in terminals, check key and mercury thermometer can be included for checking with a portable indicator.



The rigid metal case mounts flush in panel, but can be equipped with hangers for surface mounting. The galvanometer is a sturdy replaceable unit. The only maintenance is occasional dry cell replacement. Warning that dry cell must be renewed is given when a red disc appears above the indicator scale.

Separate selector switches can be used external to the indicator, if desired, or space for additional self-contained toggle-type switches may be obtained by assembling the indicator (with case removed) in a cabinet similar to that of the Micromax strip-chart recorder.

Infra-Red Ray Lamps for Drying

DRITHERM is the name under which the newly improved NALCO Infra-Red Ray Lamp will be marketed. These lamps, made by the North American Electric Lamp Co., 1014 Tyler St., St. Louis, Mo., have been especially manufactured for radiant drying and heating purposes. They represent the final development of over four years' research and practical application in a number of the country's largest plants, including automobile plants, where they are used for paint baking.

Long burning life in proportion to high efficiencies obtained, uniformity of filament materials, as well as placement of carbon filament within the bulb, and rugged construction to minimize breakage —are several features claimed for these lamps.

LUNKENHEIMER

STEEL GLOBE VALVES

With

Bonnet-Thread-Bushing

600 lb. SP-750° F.

A distinctive design with a nickel alloy bonnet-thread-bushing and stainless steel stem, seat and disc. Bushing is a separate part, highly resistive to wear at extreme temperatures with resultant longer service life.

Disc and seat ring are heat treated to provide great hardness and ground to form a pressure tight seat.

Bonnet-thread-bushing design is available in Screwed and Bolted Bonnet types; full-way or throttling; screwed or flanged.

ESTABLISHED 1862

THE LUNKENHEIMER CO.

"QUALITY"

CINCINNATI, OHIO, U. S. A.

NEW YORK CHICAGO
BOSTON PHILADELPHIA

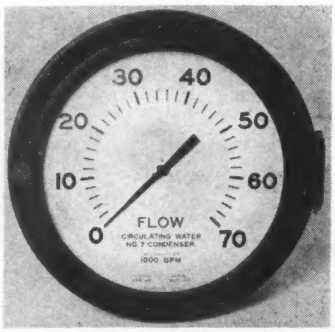
EXPORT DEPT. 318-322 HUDSON ST., NEW YORK

If you have no copy of List Price Schedule R1 giving new list prices of Lunkenheimer Products, ask your local Lunkenheimer distributor or write The Lunkenheimer Co., Cincinnati, Ohio.

15-72B-44

Flow Meter

COCHRANE CORPORATION, 17th St. & Allegheny Ave., Philadelphia, Pa., announces its electric flow meter usually standard mounted in a rectangular case

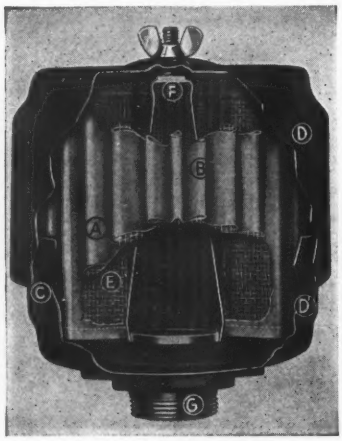


measuring 16 by 17½ in. which can be installed in a circular base 14½ in. in diameter for mounting on panel boards of limited area. The meter used is the company's standard transmitter and receiver as described in Publication 2096.

Air Filter for Small Engines

THIS NEWLY designed dry-type air filter for small internal combustion engines, compressors, pumps and all air-breathing machines, manufactured by Staynew Filter Corp., Rochester, N. Y., embodies all the Protectomotor principles. As shown in the accompanying illustration, the Protectomotor Model E is amply protected against all weather conditions by the heavily enameled steel housing shown as D and D¹. This steel housing is of simple pressed metal construction. Note the heavy wire mesh backing of the filter insert at E, and the yoke, F, both of which add to the rigid, vibration-resistant qualities of this filter. The yoke and the bolt supporting the upper shell are both spot welded. The upper shell, D, may be quickly removed and the insert lifted out for cleaning by merely unscrewing the top wing-nut. A threaded flange, G, is provided by means of which the entire unit may be easily removed or installed.

In the cut-away illustration, A indicates the radial fin construction which provides the largest possible filtering area



in the smallest possible space. The dry Feltex Filtering Medium, indicated by B, is a felt-like material of extreme fineness, which permits free air flow, yet holds back the smallest particles of air-borne matter. At C is shown the intake, approximately double the outlet area, thus keeping friction and turbulence of the entering air at a minimum. Both upright and hanging models are available in capacities ranging from 3 c.f.m. to 225 c.f.m. and in a wide selection of standard pipe sizes.

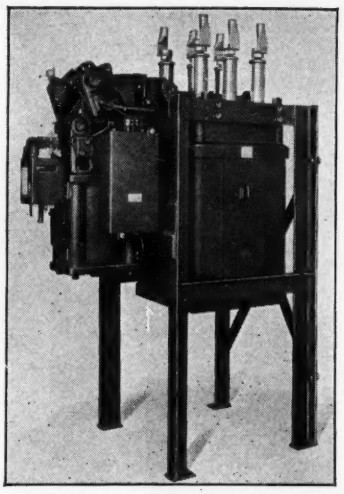
Electric Hoist

A NEW electric hoist just announced by the Coffing Hoist Co., Danville, Ill., has been given the name "Quick-Lift". It may be had with either load hook or trolley suspension, in capacities from 250 to 4000 lb., and weighs only 89 to 195 lb. This new hoist can be plugged into any circuit or current connection, either a.c. or d.c., and uses only a few cents worth of current a day. It has a heavy duty ball bearing motor, fully enclosed, high

starting torque, single and three phase. The hoist is built with lubri-seal ball bearings; gears and pinions made of special heat treated alloy steel, sealed and running in oil; hooks are drop forged and heat treated alloy steel, designed to stand 200 per cent overload; extra heavy load chain that will not kink or bend, with actual strength several times over rated capacity; fool-proof limit switches; show type brake with large braking surface assures smooth and positive operation; sensitive yet sturdily constructed controller with heavy duty contact points, and many other outstanding features.

Circuit Breaker

A NEW INDOOR OIL CIRCUIT breaker capable of wide application to central station and industrial service is announced by the Boston Works of Allis-Chalmers Mfg. Co. Designated as type KDZ-40, the breaker is of interest because its horizontal axis (a line drawn through the center of each pole) is perpendicular to the operating mechanism. This arrangement of the bushings eliminates the necessity of crossing the leads in certain applications of open and enclosed type switchboards. For the same reason, it is adaptable for replacing obsolete breakers of the same arrangement, as existing bus

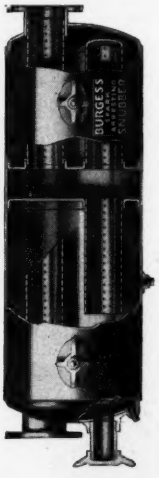


and feeder connections may be retained. The type KDZ-40 is equipped with "Ruptors," special devices used to give efficient interruption of short circuits along with low arc energy, low pressure and a minimum of oil deterioration. Other features are: Enclosed low inertia, high speed mechanism; internal hydraulic shock absorbers; silvered contacts; oil and gas separators and Bakelain bushings.

It is furnished for 600 and 1200 amp. at 15 kv. and 2000 amp. at 7.5 kv. Interrupting capacity rating 100,000 kv-a. It is arranged for flat surface mounting and for mounting in cells, switchhouses, cubicles, metal-clad switching equipments, and safety-enclosed switchboards.

Spark-Arresters for Diesels

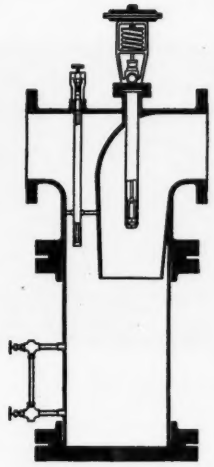
IN MANY LOCATIONS, flying sparks from the exhaust of Diesel engines are troublesome or hazardous. To trap these flying particles and at the same time prevent exhaust noise, the Burgess Battery Co., Acoustic Division, Dept. NR, 500 W. Huron St., Chicago, has developed a new spark-arresting type of Exhaust snubber.



Two methods of spark removal are utilized in this design. First, because of the large cross sectional path, the velocity of the gases is very low and the heavier particles tend to separate out by gravity. Second, the exhaust gases change direction and velocity so that the remaining finer carbon particles are thrown out due to centrifugal action. The carbon and ash drop into a large chamber in the bottom of the Snubber, where they can be removed through hand hole. It must be installed vertically.

Available in 19 standard sizes with connections ranging from 2 to 30 in. diam.—flanged to match standard 125-lb. American pipe flanges.

The COPES DESUPERHEATER



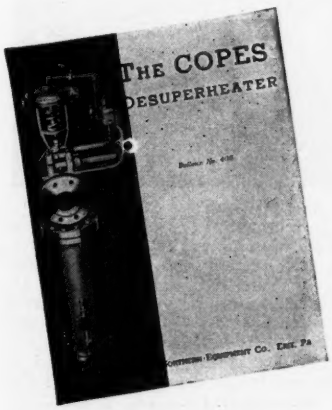
Accurate for total or partial desuperheating, on steam from 212 to 1100 degrees F. Dependable for all flows, regardless of any change in the temperature of the superheated steam entering the unit.

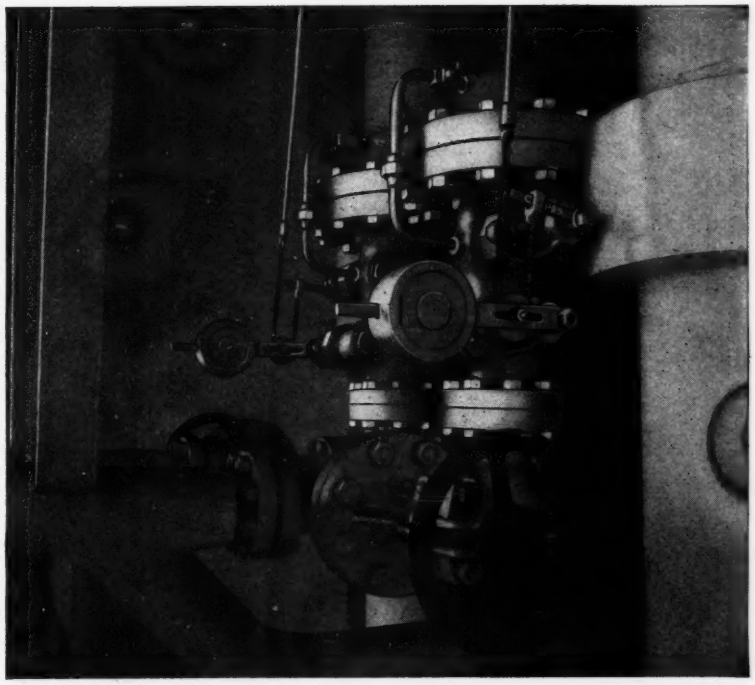
Water correctly proportioned to steam at all times because cooling water is controlled at the spray nozzle—not by any outside control valve. Final temperature held within close limits, because cooling water is completely atomized.

A self-contained unit, with a simple external adjustment for temperatures and sensitivity.

For complete information—

Write for Bulletin 405





At Baldwin Rubber Company:

"Without such instantaneous and accurate response of the feed control valve to the constantly changing load and level conditions, it would have been impossible to operate the plant at the high average efficiency of approximately 84 percent." Baldwin Rubber Company made this report on COPES Flowmatic Regulator performace with loads swinging sharply over an almost 3-to-1 range. For the complete story of accurate feed and level control, write for illustrated Bulletin 419.

NORTHERN EQUIPMENT CO., 712 GROVE DRIVE, ERIE, PA.

Feed Water Regulators, Pump Governors, Differential Valves
Liquid Level Controls, Reducing Valves and Desuperheaters

BRANCH PLANTS IN CANADA, ENGLAND, FRANCE, GERMANY AND ITALY
REPRESENTATIVES EVERYWHERE

Get closer level control with the

COPES

FEEDS BOILER ACCORDING TO STEAM FLOW•AUTOMATICALLY

FLOWMATIC

★ REGULATOR

Tension Measuring Wrenches

SNAP-ON TOOLS CORP., Kenosha, Wis., announces six Snap-on Torqometers, or tension measuring wrenches, that will handle the many diversified requirements of general industry. These six instruments are made in different sizes and recording ranges and provide the correct type of tool for any particular requirement.

These instruments are more truly precision gages than wrenches and, properly used, they will eliminate faulty conditions caused by distortion. The Torqometer, with a predetermined leverage, measures the deflection of a solid steel bar at any pressure and indicates this deflection on a dial, the reading remaining constant regardless of the position of the operator's hands on the tool handle. The dial can be pre-set to the tension reading required and pressure applied until this degree is reached . . . every nut or bolt can quickly be tested and brought to an equalized setting. The illustration shows only the four smaller sizes of these instruments.

Differential Controllers

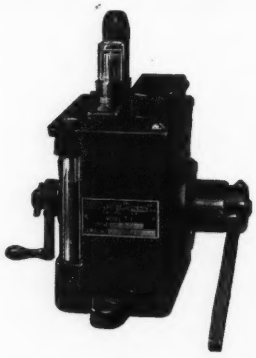
DIFFERENTIAL Controllers, made by Minneapolis-Honeywell Regulator Co., 2950 Fourth Ave. South, Minneapolis, Minn., are designed with two bellows assemblies that oppose each other and react to variations in the difference in pressure or temperature between the high and low pressure or temperature elements and are available in modulating as well as "make and break" mercury switch models.

The differential pressuretrol illustrated can be installed with an orifice to control the flow of steam or liquids, or it may be used as an alarm device on cooling water systems such as the supply line to water cooled bearings on large generators. It may also be used as an alarm on large refrigeration condensers.

Except that they are made up with temperature elements instead of the pressure bellows assemblies, the differential thermostats are similar to the differential pressuretrol and can be used for water conservation on air conditioning jobs using well water; on attic fans where one element is placed in the outside air and one in the house to turn on the fan whenever the differential between the two temperatures reaches a predetermined point; and to prevent condensation in underground wiring tunnels where it is necessary to maintain the temperature above that of the outside air.

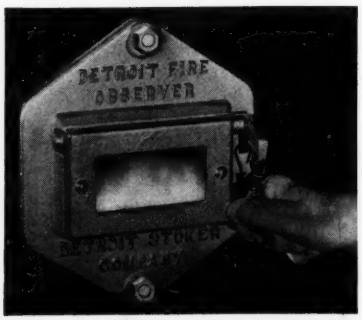
2000 lb. Lubricator

HILLS-MCCANNA Co., 2349-59 Nelson St., Chicago, Ill., announces a new force-feed lubricator capable of rendering positive performance, delivering a fraction of a drop of oil to 10 drops per stroke at pressure of 2000 lb. per sq. in. Special provision has been made to keep dirt and foreign particles from entering the feed lines by embodying fine mesh screens in the pump valve, which filter all oil delivered. The built-in unbreakable, transparent sight feed is made of the new plastic material, Lucite. Available in single or multiple feed assemblies, each valve being independently adjusted. The drive consists of a positive ratchet, totally enclosed within the reservoir. This new lubricator augments the Hills-McCanna line and provides users with 4 types, from 1 to 60 feeds, based on the positive, single plunger principle with packed stuffing boxes and ball valves.



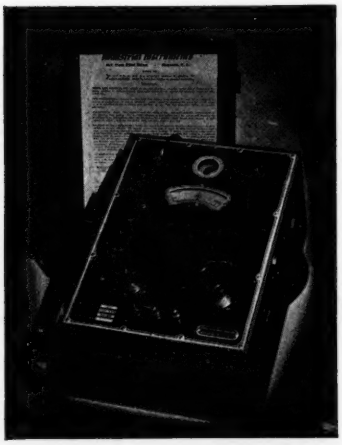
Fire Observer

A NEW fire observer or observation port has been developed by Detroit Stoker Co., Detroit, Mich. This observation port enables the operator to inspect the interior of the furnace through the colored pyrex glass covered port. The port is 6 in. wide and 4½ in. high, which gives a very liberal view of the interior of the furnace walls, fuel bed and boiler tubes without admittitng cold air to the furnace. The port is covered on the inside by a shutter, with all infiltration of air eliminated. When the shutter is raised, the port is opened and the colored glass on the outside diffuses the glare and permits the safe clear vision of the furnace. When the handle is released, the cover entirely closes the port. The pyrex glass is protected by a monel metal screen when the shutter is in the open position.



Conductivity Bridge

THE NEW CONDUCTIVITY bridge shown in the accompanying illustration is an adaptation of the Wheatstone Bridge. It operates from the 110 or 220 v. a. c. power line, is portable, self-contained, easy to use and sturdy of construction as it contains no galvanometer or other delicate part. Its purpose is two-fold: 1. For measuring the specific resistance of electrolytes. 2. For ordinary resistance measurements where an a. c. bridge may be employed.



It is useful in checking the purity of distilled water, checking the chlorine concentration of tap water, routine examination of boiler feedwater, checking and calibrating rheostats and potentiometers, carbon and wire wound resistors as well as dozens of other uses.

The instrument is manufactured by Industrial Instruments, Inc., 162 W. 23rd St., Bayonne, N. J.

"I'D HATE TO LET MY BEARD GROW 'TIL THAT ENGINE QUITS!" SAYS ENGINEER C. W. HAM

"IT WAS A GOOD ENGINE IN THE FIRST PLACE," says Mr. C. W. Ham, Diesel Engineer for Western Engine Corporation. "We built it ourselves and put it in operation in 1926. It's a stationary solid-injection engine that furnishes us power in rush times 24 hours a day and during its life has never let us down.

"It's still in good shape and produces power for our entire plant at less than the low city rate we could get.

"But the best engine ever built needs good fuel and lubrication. Every drop of oil this one ever had in the crankcase has been your Shell Talpa Oil. Every drop of fuel that's gone through it has been 'Shell Dieseline.' I don't know how *any* products could beat this perfect record regardless of price."

* * *

Shell appreciates Mr. Ham's bouquets and is proud to have shared in this record. And while we might add that Shell products can't make bad equipment into good equipment, we do believe they will do the best job that can be done in making any kind of equipment run better and last longer.

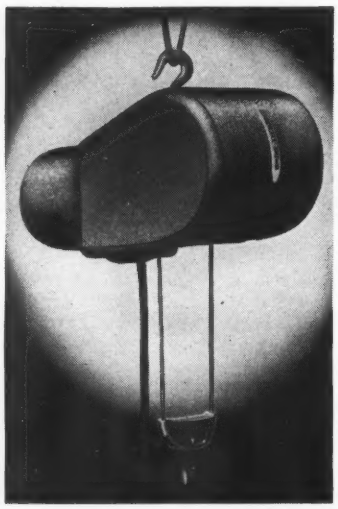
Experienced technical men are on call without obligation on all industrial lubrication and fuel problems.

SHELL

SHELL INDUSTRIAL LUBRICANTS

Electric Hoist

A NEW, completely enclosed, cable and drum type electric hoist, featuring double drum construction, push button control, electric brake, and heavy duty construction throughout has just been placed on the market by the Conco Engineering Works, Mendota, Ill. It is available for either trolley, hook or lug suspension, and in capacities from 250 to 1000 lb.



The mechanism of the Conco Torpedo Electric Hoist is fully enclosed in an oil tight, weather proof, dust proof housing which is finished in blueslate gray baked Wrinklelac. Only two gear reductions are employed in the hoist—one worm gear and one spur gear—the spur gear of high carbon steel; the worm of forged steel and the worm gear of chilled phosphor bronze. All gear shafts operate on anti-friction bearings, with gears and shafts fully enclosed and operating in a bath of oil. The cast iron drums are thirty times cable diameter. A minimum factor of safety of eight is provided for cable on hoists of all capacities.

Self-Regulating Battery Charger

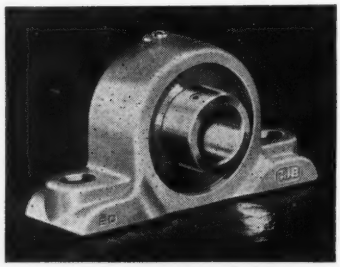
A NEW COMPLETELY AUTOMATIC and self-regulating electronic battery charger called the Phano-Charger has been developed by General Electric for charging and maintaining storage batteries used in power plants, substations, hospitals, public buildings, and other places for standby service, control power, and emergency lighting. By using industrial-type metal phanotron rectifier tubes, moving parts are eliminated thus assuring long life for the equipment and practically silent operation. The chargers are available in three sizes: 4.5 amp. and 12.5 amp. to operate from a single-phase power supply, and 25 amp. to operate from a three-phase a.c. supply.

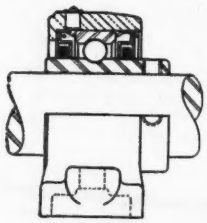
The Phano-Charger is readily adjustable over a wide voltage range, making it possible to trickle-charge a fully charged battery. The rectifier will then automatically furnish more current up to the safe current limit of the tubes when the battery-terminal voltage is diminished. This adjustment is also useful in stepping up the charging rate in the event the battery has become discharged on excessive overloads and must be brought back to a fully charged condition in the shortest possible time.

The voltage characteristic of the Phano-Charger is exceptionally flat from no load to full load and then breaks abruptly into a relatively constant-current characteristic. The voltage regulation is maintained within plus or minus one per cent from no load to full load and for a variation in the a-c line voltage of plus or minus five per cent. A saturable reactor provides a means for close regulation, and inherent protection for the tubes, regardless of momentary or sustained battery loads.

Bearing Pillow Blocks

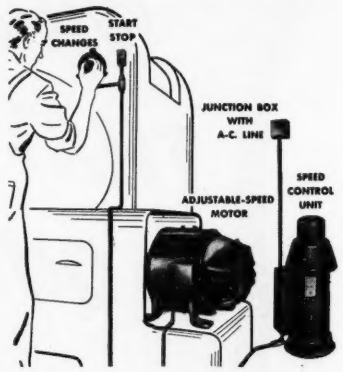
A NEW series of light-duty ball bearing pillow blocks has been put into production by the Ahlberg Bearing Co., 3015 West 47th St., Chicago, Ill. These Pillow Blocks consist of a specially designed Ahlberg single row bearing in a sturdy and neat die-cast housing. The ball bearing is assembled to provide for shaft deflection and misalignment up to 1 deg. Seals are of a floating construction which eliminates friction and increases the life of both seals and bearing. The seals are made of Neoprene, a long-wearing synthetic rubber, which is not affected by oil or grease. Standard shaft sizes are ½, 5/8, ¾, 15/16, 1, 1⅛ and 1-3/16 in.





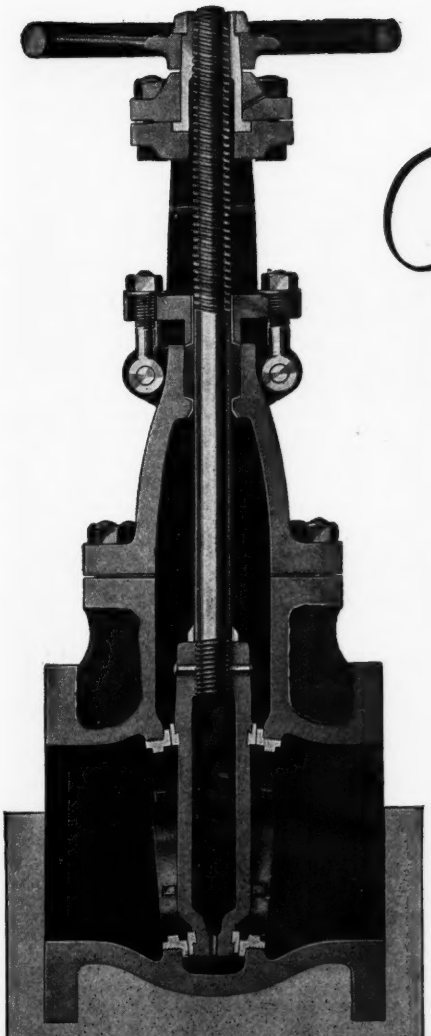
Adjustable Speed Drive

AN ALL-ELECTRIC, a.c., adjustable-speed drive, has been developed by The Reliance Electric & Engineering Co., Cleveland, Ohio, for use on three-phase, 60-cycle, 220, 440, and 550 v. a.c. circuits. The new drive consists of a control unit and an adjustable-speed motor which is applied directly to the machine to be driven. This speed-changing combination is intended to bring to motor users having only an alternatting current power supply an economical means of varying the operating speeds of their small motors (from one hp. up) over as much as a 12 to 1 range. To be produced in quantity for off-the-shelf delivery, the Reliance V*S Drive, as it will be known, is composed of elements already common to the ordinary squirrel-cage motor and d.c. generator. Three wires from the a.c. power source are connected to the control unit exactly as would be done with any motor and control. From the control unit, secondary circuits are run to the driving motor, to a speed adjuster, and to start and stop buttons. The driving motor is a Reliance Type T, designed particularly for adjustable-speed service. The motor can be started and stopped without interfering with the speed setting. Moreover, the speed can be changed while the motor is in operation. Quick stopping is obtained by regenerative braking. Furthermore, no clutches of any description are needed since plenty of torque has been provided for all starting conditions.



Electric Blower

THE BREUER ELECTRIC MFG. CO., 3100 N. Ravenswood Ave., Chicago, Ill., announces changes in their line of portable electric blowers. Waterlift on the 1 hp. model has been raised from 46¼ in. to 52 in. with porportionate increase on three smaller models. Blowers have also been equipped with rubber nozzles and new double grease seal ball bearing which requires no oiling. Tools have been redesigned—double-curved extention handle for floor cleaning has been added to increase cleaning efficiency and speed when used as a suction cleaner.



Protected against corrosion . . . . .
by bronze bushings at all stem contact surfaces, and rust-proofed stuffing box bolts

Protected against side play . . . . .
by yoke nut rotating in machined yoke recess, and deep machined disc guides

Protected against leakage . . . . .
by extra-wide accurately fitting seat and seat ring faces made of specially hard bronze

Protected against operating strain . . . .
by large-diameter high-strength stem with heavy acme threads

Protected against distortion . . . . .
by strong oval body and flanges, with reinforcing ribs

Where Valves may be vulnerable KENNEDYS *are* FULLY PROTECTED!

. . . . one of the Extra Values in KENNEDY Iron-body Wedge Gate Valves

WHEREVER a valve is subjected to destructive influences, there you will find special protective provisions in every Kennedy type.

Some of these provisions in Kennedy Standard Iron-body Wedge Gate Valves, for example, are listed in the panel at the left. In addition, the bodies, bonnets and yokes are made of exceptionally dense, fine-grained metal which is 50% stronger than ordinary cast iron, and all bronze parts are made of tough, hard red metal of at least 50,000 lb. tensile strength.

Exceptional protection against destructive influences is but one of the extra values built into every Kennedy Valve at no extra cost to you. Be sure to specify Kennedy Wedge on your next iron-body gate valve order—you will be glad you did so.

Write for bulletin describing these valves in detail

The Kennedy Valve Mfg. Co., Elmira, N. Y.

KENNEDY *VALVES with Extra Value*

News from the Field

FISHER GOVERNOR Co., Marshalltown, Iowa, has appointed the Vinson Supply Co., 220 North Boston Ave., Tulsa, Okla., its exclusive agent for Fisher Control Specialties in the Mid Continent Area which will include Oklahoma, southern New Mexico, western Arkansas, Dallas and Fort Worth areas of Texas, West Texas and the Texas Panhandle.

ROBERT E. KEYES, Chief Engineer, the Cooling & Air Conditioning Division, B. F. Sturtevant Co., died at the Metropolitan Hospital, Philadelphia, on May 29th. Mr. Keyes is survived by his widow, Maude E. Keyes, who is maintaining their residence at 51 Glendale Road, Wellesley Hills, Mass.

R. E. HOWE, president, Appalachian Coals, Inc., has accepted appointment as a member of the Natural Resources Department Committee of the Chamber of Commerce of the United States of America. He will serve during the balance of 1939. Howe is a director of Bituminous Coal Research, Inc.

THE RELIANCE GAUGE COLUMN Co. announces the appointment of L. C. McKay, 533 Mayo Bldg., Tulsa, Okla., as exclusive Sales Representative for the state of Oklahoma and the Panhandle territory of Texas.

CUTLER-HAMMER, INC., Milwaukee, has announced the appointment of G. S. Crane to Vice-President in Charge of Sales and Engineering. He has been associated with the company for 29 years, serving successively in the Engineering and Sales Departments.

H. C. BEAVER, President, Worthington Pump & Mach. Corp., announces the election of Clarence E. Searle, of Bronxville, N. Y., and Hobart C. Ramsey, of Short Hills, N. J., to the Board of Directors, and Edwin J. Schwanhausser of Buffalo, N. Y., as vice-president.

Edwin J. Schwanhausser's connection with Worthington dates back to 1915, when he graduated from Stevens Institute of Technology. Assigned to the Harrison (N. J.) Works, he served in a number of capacities, reaching the position of Assistant Works Manager in 1927. In 1929 he was transferred to the Buffalo (N. Y.) Works, as Works Manager, a position he will continue to hold. Since going to Buffalo, he has been prominent in civic activities, serving in 1937 and 1938 as president of the Buffalo Chamber of Commerce.

Later H. C. Ramsey, as Vice-President in charge of operations of Worthington Pump & Machinery Corp., announced several promotions to key positions. L. C. Ricketts, recently general superintendent of the Harrison Works, has been appointed Manager. W. D. Sizer, who joined Worthington in 1920, is appointed executive engineer in charge of all engineering activities at Harrison, and B. R. McBath assumes full responsibility as engineer in charge of the centrifugal engineering division, succeeding W. D. Sizer. J. H. Brautigam succeeds W. H. Scherer as manager of the Holyoke Works. W. H. Scherer will devote his entire time to the further development of manufacturing methods in all of the corporation's plants, as assistant to H. C. Ramsey with headquarters at Harrison.

W. W. MALLORY has been named president of the Memphis Light, Gas and Water Commission which will direct the operations of the Memphis Power and Light Company facilities to be purchased by the city and TVA.

BEN W. MARR has been re-elected president of the Columbus & Southern Ohio Electric Co. Other officers renamed were John B. Poston, executive vice president; Morgan L. Evans and W. A. Wolls, vice presidents; John A. Niles, secretary, and Thomas J. Stiverson, treasurer and assistant secretary and auditor.

JEROME J. FEENEY, secretary of the Madison (Wis.) Gas and Electric Company since 1924, has been named vice president of the Interstate Power Company, Dubuque, Iowa.

DR. ARTHUR ROBERT BURNS, Columbia University economist, has been appointed research director of the Twentieth Century Fund's survey of the problems arising out of Government relations with the light and power industry.

JOHN R. SHEA, assistant engineer of manufacture at the Western Electric Company's branch at Kearny, N. J., has been named successor to William H. Meese as works manager of the firm's Point Breeze plant. Mr. Meese died last month from a heart ailment.

THOMAS T. LYONS and Stanley C. Beck, employees of the Arkansas Power and Light Company, were presented with gold medals by Harvey Couch, president of the company, for having saved the life of Carl Ledbetter, a fellow employee. Richard Klingst, another employee, was presented a certificate of assistance.

WATER POWER in the United States is reported by Federal Power Commission as of Jan. 1, 1939, as 17,948,906 hp., an increase of 4 per cent during 1938. Of this 88.2 per cent is in electric utility plants, installed in 2869 plants, or 55.8 per cent of the total number of plants. Greatest increases were in Nevada, Oregon, Tennessee, Montana and Texas, accounting for 580,757 hp. of the total 684,209 hp. increase.

DURING the winter months a course in Combustion has been conducted for the Power Department employees of the Dow Chemical Co., Midland, Mich. Having a total enrollment of 96, the class was divided into two groups, each group meeting one evening each week in the Dow Chemical's new modern auditorium, which is sound proofed, air conditioned and has "sound" motion picture projectors in addition to the usual slide projectors. The course, sponsored by the local N.A.P.E. and instructed by L. L. Moran, Assistant Chief Operating Engineer, was held for a period of 14 weeks with an average attendance of 62.5 per cent. The course was free except for the cost of text books which was met by the individual members of the class.
NEWS

JOHN W. CLARKE, 327 South La Salle St., Chicago Ill., has been appointed as agent for the Roller-Smith Co. to cover the eastern part of the state of Iowa.

CONTRACTS have been let by Battelle Memorial Institute, Columbus, Ohio, for the construction of a new research laboratory to take care of the expanding volume of industrial research. The increased laboratory and office space at Battelle have been made necessary by the growing research activity in metallurgy, fuels, ceramics, and chemistry. The new construction consists of a wing extending from the end of the present main building that will provide approximately 50,000 sq. ft. of space on five floors. In this will be chemical and metallurgical laboratories, photographic and metallographic departments, physics laboratories, and a large industrial laboratory.

DANIEL DELANEY POWERS, grandson of Dan Delaney, former manager of the Dearborn Chemical Co. at Cincinnati, will represent the Dearborn Chemical Co. at Cincinnati, with offices located in the Union Central Building.

THIS YEAR'S joint meeting of the Coal Division of the American Institute of Mining and Metallurgical Engineers and the Fuels Division of the American Society of Mechanical Engineers will be held in Columbus, Ohio, October 5, 6, and 7 and will include two days of technical sessions, a morning of visits to industrial plants. R. A. Sherman, supervising fuel engineer at Battelle Memorial Institute, has been named chairman of the general committee for the meeting. Professor S. R. Beitler, of the Department of Mechanical Engineering, Ohio State University, is chairman of the local committee on arrangements.

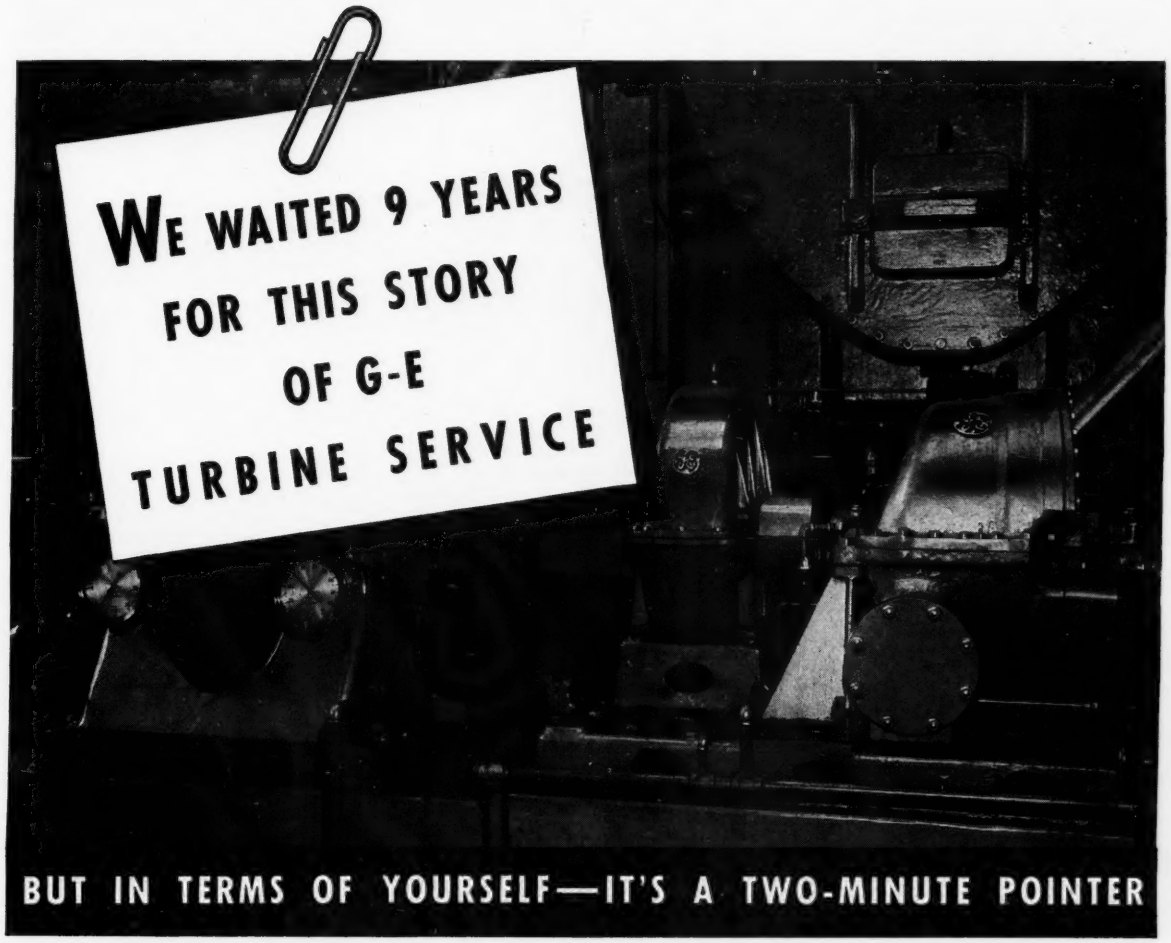
REMOVAL of its Chicago office to 300 W. Jackson Blvd., has been announced by the Crouse-Hinds Co.

S. J. HORRELL has been appointed assistant sales manager of power piping division of Blaw-Knox Co. Mr. Horrell is a mechanical engineer of 18 yr. experience in power plant and piping work. During the past 9 yr. he was with Grinnell Co. in the design and sale of prefabricated piping for high pressure-high temperature service.

MAX C. BARTLETT, associate engineer for 15 yr. with Burns & McDonnell Engineering Co., has been appointed general manager of the Water & Lighting Department of the municipal utilities at Knoxville, Tenn., the largest city in the T.V.A. territory to acquire T.V.A. power. All utilities will be under general control of a non-partisan utility board of five. The water and light under one management will also serve suburban territory. The water works pumping station is now being electrified under plans prepared by Burns & McDonnell Engineering Co.

CONTROLLED STEAM GENERATORS, INC., 330 W. 42nd St., New York, N. Y., announces the appointment of J. G. Coutant as Vice President in charge of engineering work in connection with design and construction.

FRANK B. CONDON, formerly with the Engineering Department of the Pennsylvania Railroad and later with the Airtemp Corp., has joined the staff of Sheffler-Gross Co. and will specialize in sales and engineering with particular reference to air conditioning, heating and ventilating work.



BUT IN TERMS OF YOURSELF—IT'S A TWO-MINUTE POINTER

YES, we waited nine years for this story to prove G-E turbines do stay young longer. For nine years is the length of time the oldest of 12 G-E mechanical-drive turbines in a large Midwestern plant* have been delivering continuous, dependable, low-cost service. And on the job all of them have turned in the same sort of performance—have helped to prove the reliability of G-E turbines.

But here's what the Chief Engineer has to say of all 12 of these G-E turbines.

"We have had no trouble with these units."

"Maintenance cost has been negligible . . . lubrication costs extremely low . . ."

*Name will be supplied on request.

"Would not hesitate to recommend these turbines to prospective customers."

Now that's a lot to be able to say about nine years of experience with 12 hard-working turbines. In terms of dollars and cents it expresses the biggest reason why you should make your next turbine purchase General Electric. For G-E turbines do stay young longer—a fact that has been proved, time and again, by measuring minimized bearing wear and bucket erosion.

Call your nearest G-E office for further details; ask the turbine specialist how G-E turbines can save money on *your* job. General Electric Company, Schenectady, N. Y.

GENERAL ELECTRIC

720-305

THE RESISTOFLEX CORP. has removed its Dover, New Jersey, plant and its executive offices (formerly in New York City) to Belleville, N. J., where the completed first unit of the new Resistoflex manufacturing plant is situated. Two additional factory units to be erected at the Belleville plant, will take care of further expanding production needs.

CLARENCE S. PARKER, who has recently completed fifty years of continuous service with the Revere Copper and Brass, Inc., was presented with a plaque at a dinner held on May 26 at the Bedford Hotel.

WALTER F. PERKINS, vice president of Koppers Co., in charge of its Baltimore operations, has been elected a member of the board of directors.

IN ITS annual meeting, held at Pittsburgh, June 1, W. J. Westphalen, president and general manager of Laclede-Christy Clay Products Co., St. Louis, was re-elected for the second consecutive term as president of the American Refractories Institute.

THE CLEVELAND District Offices of The Linde Air Products Co., Carbide and Carbon Chemicals Corp., and Haynes Stellite Co., all of which are units of Union Carbide and Carbon Corp., are now located at 1517 Superior Avenue, Cleveland. The entire building is occupied by sales and process service departments of these companies.

The District Managers are H. H. Dyar, for The Linde Air Products Co.; E. E. Fogle, for Carbide and Carbon Chemicals Corp., and F. P. Shephard, for Haynes Stellite Co.

LUKE E. SAWYER, formerly assistant general superintendent of The Babcock & Wilcox Tube Co., Beaver Falls, Pa., has been appointed general superintendent.

THE SIXTH International Heating and Ventilating Exposition will be held in Lakeside Hall, Cleveland, Ohio, January 22-26, 1940. This exposition is held under the auspices of the American Society of Heating and Ventilating Engineers in conjunction with its Annual Meeting. The National Warm Air Heating and Air Conditioning Association will hold its national meeting at Cleveland during the same week, as will other organizations. Principal classifications of exhibits for the Exposition at Cleveland include steam, air, and hot water heating, complete air conditioning, humidification and dehumidification, central heating, unit heating, fans, blowers, ventilating ducts, insulations, instruments, tools and shop equipment, electrical machines and accessories, metals and materials. The exposition will be under the direction of Charles F. Roth, president of the International Exposition Co., Grand Central Palace, New York.

HAGAN CORP. announced the appointment of D. J. Erikson as Vice President, in Charge of Sales, for Hagan and for its subsidiary companies, Hall Laboratories, Inc., The Buromin Company and Calgon, Inc. He will have charge of the sale of Hagan Automatic Combustion Control for power plants (industrial, power, and marine fields) and for heavy duty furnaces in the steel industry; Hall Laboratories System of Boiler Water Conditioning; Buromin for boiler water conditioning; Calgonite for hotels, restaurants, clubs, hospitals, etc.; Calgon for its various applications in the laundry, dairy, food, textile, leather, paper and other industries; and Calgon for household uses.

Bureau of Standards Begins Erection of High-Voltage Laboratory

NATIONAL Bureau of Standards, Washington, has begun the erection of a new high-voltage laboratory, to be used for studies in the measurement of electrical energy, X-ray apparatus, testing of electrical installations and allied work. The development and use of the million-volt X-ray for therapeutic treatment of cancer will be a phase of initial activity at the new laboratory. In addition to other equipment, installation will include a special 250,000-v. transformer and auxiliary apparatus. An appropriation of $350,000 has been made available for building and equipment.

William Clifford Stevens

WILLIAM CLIFFORD STEVENS, Vice-president in charge of Engineering, Secretary and Director of Cutler-Hammer, Inc., died on May 15 at the age of 55 yr. After graduating from Cornell University in 1906 with a degree in mechanical engineering, Mr. Stevens joined the Engineering Department of Cutler-Hammer, Inc., at the Milwaukee headquarters. The following year he was transferred to the Pittsburgh sales office. From 1910 to 1912 he was associated with the sales department at Milwaukee and in 1913 was made District Manager of the Western Division out of Chicago. A year later he became Eastern District Manager with offices in New York City. In 1917 he returned to the Milwaukee headquarters as General Sales Manager—an office he directed until 1924 when he was placed in charge of the Development Department. Mr. Stevens had a Fellowship with the American Institute of Electrical Engineers. Since 1930 he was also a Director of Globe Union, Inc., Milwaukee, Wis. He is survived by his wife, a son and a daughter.

Engineers at the Fair

WEDNESDAY, July 13, has been designated as Engineers' Day at the Golden Gate International Exposition by the San Francisco Engineering Council, and the entire engineering profession is invited to attend this commemoration of the engineer's contribution to human welfare. This celebration will take place during the convention week of A. S. M. E. and the A. I. M. M. E. It closely follows the conventions of the A. I. E. E., the I. R. E., and the A. A. A. S. and closely precedes the convention of the A. S. C. E. and Western Chemical Congress.

For the Engineer's Library

Recent bulletins and catalogs on power plant equipment listed for your convenience in securing specific information. Power Plant Engineering will be glad to procure for you any free literature that you desire.

Prime Movers

Water Wheel Generators is the title of a new leaflet (No. 2351) which gives a substantial list of generators for all manner of ratings from 31 kv-a. to 65,000 kv-a. Allis-Chalmers Mfg. Co.

Steam Turbines—Bulletin S-127 is an 8-page reprint entitled Steam Turbines in Oil Refineries outlining the mechanical and financial advantages of steam turbine drives. Terry Steam Turbine Co.

Combustion

Regulators and Burners—A new general catalog covering NGE Wilgus pressure regulators, liquid level controls, gas burners and oil burners, and fuel oil pumping systems has just been issued. Included is a rapid capacity calculator made up as a 6 in. circular celluloid slide rule for finding the size or capacity of regulators for gas, air, steam, light oil or water. The Natural Gas Equipment Inc.

A Survey of Sulphur Dioxide Pollution in Chicago and Vicinity, by Alamjite D. Singh, is the title of Circular No. 36, which has been issued by the Engineering Experiment Station of the University of Illinois, Urbana. In making the survey, the city was divided into seven districts according to the expected intensity capacity for the production of sulphur dioxide, and the importance of the effects.

Lubrication

Oil Refiner — Youngstown Miller Co., announces the development of an oil purifier or refiner in a large size adequate to take care of a 5000-hp. Diesel plant. The new model is designated as AV-75; capacity 75 gal. in 75 minutes. Further details of the equipment are described in Bulletin Y-M 1-A.

Viscosity Testing — Bulletin 701 gives complete specifications on a new Saybolt Viscosimeter with automatic constant temperature control accurate to plus or minus 0.03 deg. F. for determining oil viscosities according to Method D 88 of the American Society for Testing Materials. Precision Scientific Co.

READING-PRATT & CADY
DOUBLE GLAND ASBESTOS PACKED COCK

Easy TO TURN...

This Double Gland Asbestos Packed Cock holds its seal and operates freely throughout its entire range of temperatures.

The top gland holds the plug to its seat at any predetermined pressure.

The second gland is separately controlled to compress the packing. It does this without pressure on top of plug. Thus, seal is obtained without binding. The plug turns easily at all temperatures.

Advantages of this double gland U-groove asbestos packed cock have been proved in refineries, paper mills, steel mills; in by-products, soap, dye-stuff and power plants — to mention a few... Recommended where liquids carry solids in suspension; for viscous fluids, oils, acids, alkalis; where globe, angle or gate valves fail and ground cocks are not satisfactory... Write us. This R. P. & C. cock may solve your problem, too.

U-GROOVE ASBESTOS PACKING: Prevents metal to metal contact, minimizes friction, gives tight seal, insures seal with less friction at temperature rise, provides cushion to absorb expansion differential between plug and body.

READING-PRATT & CADY

READING-PRATT & CADY DIVISION · BRIDGEPORT · CONNECTICUT

AMERICAN CHAIN & CABLE COMPANY, Inc.

AMERICAN CHAIN DIVISION • AMERICAN CABLE DIVISION • ANDREW C. CAMPBELL DIVISION • FORD CHAIN BLOCK DIVISION • HAZARD WIRE ROPE DIVISION • HIGHLAND IRON AND STEEL DIVISION • MANLEY MANUFACTURING DIVISION • OWEN SILENT SPRING COMPANY, INC. • PAGE STEEL AND WIRE DIVISION • READING-PRATT & CADY DIVISION • READING STEEL CASTING DIVISION • WRIGHT MANUFACTURING DIVISION • IN CANADA: DOMINION CHAIN COMPANY, LTD. • IN ENGLAND: BRITISH WIRE PRODUCTS, LTD. • THE PARSONS CHAIN COMPANY LTD. • *In Business for Your Safety*

Lubrication — A concise pictorial resume under the title Serving Industry has been prepared by the Sun Oil Company. The booklet also contains many lubrication recommendations and should prove to be a handy reference and guide for those interested in obtaining lubrication efficiency and production economy.

Electrical Equipment

Electrical Specialties and Maintenance. The complete line of motor and other maintenance equipment manufactured by the Ideal Commutator Dresser Co. is presented in a new 64-page catalog and handbook. Because of the many unusual and useful products handled by this company, this catalog is a very intriguing book and every plant operator or maintenance man will be interested in it. It lists everything from commutator maintenance tools and coil winders to electric etching devices and "wire units." At the back of the book are excellent hints on commutator care and the operation of direct current generators as well as a dictionary of electrical terms and useful tables. The book is well printed and illustrated.

Electrical Equipment — Five new catalogs have recently been issued in which various types of electrical equipment are described. Catalog 6-C covers operating mechanisms and attachments and typical mounting arrangements for Turblator oil breaker. Although no new equipment is shown, all technical data have been brought up to date. The Hipot Insulator and Bushing Tester is described in Catalog 11-a. New applications of the Hipot Potential Indicator are discussed in Catalog 11-b. Catalog 12 covers a new type C control relay which is available as single pole or two pole devices. Classes 150-TCR-2 and 250-TCR-2 oil circuit breakers are described in Catalog 6-d. Roller-Smith Co.

Electrical Testing Instruments. Six different types of instruments that operate on the "Megger" cross-coil ohmmeter principle are described in Bulletin 1600 issued by James G. Biddle Co. These instruments include the well-known "Megger" insulation testers, ohmmeters and ground resistance testers, as well as the Ducter low resistance testing set, Divine water testers and purity meters and "Megger" capitance meters. A color chart (Bulletin 1605) is included showing graphically these various "Megger" instruments covering a resistance range from one-millionth of an ohm up to 20,000 megohms.

Switchgear and the World's Fair. The World's Fair Substation of the Interborough Rapid Transit Co. is described in Bulletin 3905 issued by I-T-E Circuit Breaker Co. It describes the full automatic control used in this 625 v. rotary converter substation which is of major importance in the transportation system to the New York World's Fair. In addition to its technical aspect, the bulletin develops much interest for the layman in that it presents a double page map of transportation routes, both rail and road, from the metropolitan area to the Fair. The I-T-E. Circuit Breaker Co. plans to conduct inspection trips for interested parties through this completely automatic station and with each bulletin is enclosed an invitation to this inspection trip.

Small-plant and Industrial a.c. Switchboards, with knife switches and fuses, are described in a new leaflet, Descriptive Data 31-133. The switchboards are 240- and 480-v., three-wire, 60-cycle, three-phase, ungrounded. The panels are designed especially for control of small generators, incoming and outgoing feeder lines, and transformers. They are applicable where the total connected generator capacity does not exceed 250 kv-a. at 240 v., or 500 kv-a. at 480 v. and within the knife-switch rating of 600 amp. Westinghouse Electric & Mfg. Co.

Stainless Electrodes—Each package of McKay Certified Stainless Electrodes contains a certification of weld deposit analysis rather than the wire analysis. The certification process of weld deposit analysis and the welding procedure for the various stainless steels are described in a 16-page booklet. The McKay Co.

Stroboscopes. The May issue of the General Radio Experimenter describes two new industrial stroboscopes as well as the operation of the G. R. Variac in oil. General Radio Co.

Water Treatment

Water Conditioning—A new bulletin about Zeolite Water Softeners and other water conditioning equipment has just been published. Four modern outstanding types of zeolite water softeners and their operating principles are discussed in this interesting treatise. Other subjects discussed are iron and manganese removal, aeration, and boiler water systems—external and internal types. Elgin Softener Corp.

Strainer Head—A strainer head for use with filters and softener underdrain systems which is said to be proof and which contains a self-adjusting flapper plate is described in a two-page bulletin No. 2217 issued by the Permutit Co.

Water Treatment — Equipment to treat water by the cold lime process by the Permutit Spaulding Precipitator is described in 16-pp. bulletin 2204. The Permutit Co.

Mechanical Power Transmission

Couplings—A new and comprehensive catalog of Morse Flexible Couplings, Bulletin 57, contains complete engineering data, installation and operating information, and recommended applications for the entire Morse flexible couplings line. Morse Chain Co.

JFS-Jr. Vari-Speed Controls are illustrated and described in a new bulletin giving features of application, operation and specifications. Columbia Vari-Speed Co.

Power Transmission Book — This new 272-page handbook, Book No. 1600, of modern power transmission units, contains complete design and application data, dimensions, weights, list prices, cross-indexed for the convenient use of design engineers and plant managers. Link-Belt Co.

Nordstrom Flexible Coupling Valves are illustrated and described in a new 12-page Bulletin V-129. Each piece of equipment is described and specifications and prices are given. The Merco Nordstrom Valve Co.

HELPFUL BULLETINS

Many useful engineering bulletins and catalogs are offered in the news and advertising pages of POWER PLANT ENGINEERING. It costs the manufacturers a good deal of money to produce and mail this kind of engineering information. They are glad to put this material to work but it will be appreciated if you will request only literature in which you have a particular interest.

To secure this valuable information all you need to do is write on the coupon below the number of the page on which the item is published, the name of the company offering the literature, and the bulletin number, catalog number, title, or other brief description so we will know exactly what you want. All material is, unless otherwise stated, sent with no charge or obligation of any kind to you.

Fill in this coupon with pencil—detach and mail

POWER PLANT ENGINEERING, Readers' Service Department
53 W. Jackson Blvd., Chicago, Ill. **July**
Please send me the following literature:

Page Number	Name of Manufacturer or Advertiser	Bulletin or catalog number or description of material

Name ..... **Title** .....

Company .....

Address .....

GOOD ENOUGH for the WORLD'S FINEST

Pittsburgh Seamless

LOCOMOTIVE TUBES

In this masterpiece, representing the ultimate in modern steam locomotives, it is significant that only *seamless* was used for the tubular members. We are proud that Pittsburgh Seamless Boiler Tubes and Superheater Flues were selected for the "heart" of this superlative mobile power plant.

PITTSBURGH STEEL COMPANY, PITTSBURGH, PA.

Pittsburgh Seamless

BOILER TUBES • HEAT EXCHANGER TUBES • CONDENSER TUBES • POWER PIPING

Tools

Drills—Catalog 96 covers a complete line of drills and drill sets, reamers and miscellaneous tools. A special section entitled Technical Data gives a complete list of drill facts for the apprentice. The catalog contains 86 pages and is metallic bound. Whitman & Barnes Division of United Drill and Tool Corp.

Tools—Catalog 39 consisting of 92 pages covers a full line of alloy steel sockets, wrenches and small hand tools. Bonney Forge & Tool Works.

Pumps and Compressors

Air Compressor—Type 20 vertical, stationary, two-stage, high pressure air compressors for starting internal-combustion engines are the subject of an illustrated description leaflet, Form 2437, published by Ingersoll-Rand Co.

Compressors—A new 16-page catalog, 3907-PG, presents a complete line of Utility Stationary Air Compressors for industrial application. Sizes from 85 to 600 cu. ft. capacity are listed in an assortment of assemblies. Operating data, detailed specifications and pictorial design features are included. Schramm, Inc.

Variable Capacity Pump—The Aldrich-Groff Powr-Savr a controllable capacity pump of the vertical triplex plunger type, giving variable delivery from a constant speed drive, is described in a new 8-page folder, Data 65, issued by The Aldrich Pump Co.

Metals

A hardness conversion table for nickel alloy steels has been compiled by, and may be had on request to, The International Nickel Co., Inc.

Heat-Treated Gearing — Characteristics and advantages of heat-treated hardened gears are outlined in a new 16-page booklet, Technical Data 71,000, which describes the Westinghouse Nuttall method of treatment, control and quenching; compares properties of different materials; defines heat treatment and case hardening; and illustrates these discussions by tables, charts and reproductions of photomicrographs. Westinghouse Electric & Mfg. Co.

Refractories

Refractory — Furnascote, a highly refractory air setting mix is illustrated and described in a new bulletin issued by the Laclede-Christy Clay Products Co.

Refractories—A new bulletin covers Types E and F furnace walls and arches for boilers. The off-set joints featured by Economy Refractories are graphically described. Furnace Economy Co.

Refrigerating Equipment

Refrigerating Machinery Standards—Under the title Equipment Standards Supplement A, the Refrigerating Machinery Association, Southern Bldg., Washington, D. C., published a 14-page book of supplementary standards covering base specifications for self-contained ammonia units, ammonia brine cooler ratings, showing basic heat transfer curves, and Freon-12 Mains, showing tonnage allowances for various size lines; also standard nomenclature for reciprocating compressors. Copies are available from the Association at 25 cents each.

Corrosion in the Refrigeration Industry is the title of a 10-page booklet dealing with the practical application of the chromate treatment for combating effects of refrigerating brine. Mutual Chemical Co. of America.

Machines and Progress — A new chart measuring 4 ft. 10½ in. by 1 ft. 9½ in. prepared by Leighton A. Wilkie, President of Continental Machines, Inc., has been made available for distribution. This graphical broadside is an authoritative treatise on industrial progress and presents a very interesting economic study. Continental Machines, Inc.

New Engineering Books

Engineering Standards

Technical Memoranda on Automatic Control, 1938. Published by The Industrial Instrument Division, Scientific Apparatus Makers of America, Chicago, Ill. Size 8½ by 11 in., planagraphed; 69 pp.; paper bound. Price $3.00.

In 1936 the A. S. M. E. organized a committee on Industrial Instruments and Regulators. Since a considerable portion of the literature available on this subject is in foreign languages, one of the early activities of the Committee was the appointment of a sub group on translation under the Chairmanship of Dr. M. J. Zucrow. The report of this Committee was published through the cooperation of the S. A. M. A. The present volume contains the translation of the work of six foreign authors as follows: Self-Regulation by Theodore Stein; Regulators by G. Neumann and G. Wunsch; Regulation of Power Plant Variables by Josef Kronert; Laws of Direct Regulation on a General Basis by Walter Schmidt; and An Experimental Study of Regulation by N. A. Tenot.

Practical Electric Illuminations and Signal Wiring Methods. By Terrell Croft, revised by George H. Hall. Third Edition. 351 pages. 293 illustrations. 6 by 8¼, cloth. McGraw-Hill Book Co., Inc., 330 W. 42nd St. New York, N. Y. 1939. Price $3.00.

Since the last edition of this volume was published in 1929 there have been so many developments in illumination methods and their application that a revision of this book was deemed desirable. As Mr. Croft was unable to undertake this revision, Mr. Hall was authorized to do it.

The purpose of this book is to give practical men the rules, methods, diagrams, etc., needed in handling electrical jobs. It covers the practical elements of illumination in all its aspects —analysis of lighting requirements, design of circuits, selection, and installation of fixtures, including the latest sodium vapor and mercury vapor lamps. It also covers signal wiring in line with Code requirements, and presents a large collection of signal circuit diagrams.

Condenser Standards. Published by the Heat Exchange Institute, 90 West Street, New York City. Size 8½ by 11 in., 38 pp., paper bound. Price $1.00.

This is the second adition of the condenser section of the standards of the institute. It is in two parts bound together; Part I dealing with surface condenser standards, Part II with barometric and low level jet condensers. These Standards contain material on nomenclature, definitions and illustrations; condenser performance; materials of construction, relief valve sizes; air pump capacity; tubing characteristics; air-water vapor mixture data; and pressure temperature conversion tables.

Electrical

Winding Alternating Current Motor Coils. By G. A. Van Brunt and A. C. Roe. First edition. 281 pages illustrated, 6 by 9 in., cloth. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd. St., New York, N. Y. 1938. Price, $3.00.

The degree to which specialization has been carried in the electrical art is well illustrated by this book devoted entirely to winding coils for alternating current motors. Yet, when one considers the countless varieties of sizes and types of motors in use it is not surprising that a book of this kind is necessary. For if the number of types and sizes of motors is large, the number of types of coils used in these motors is even greater, and unless engineers and repairmen have no general source of information regarding the design and construction of these coils, the task of servicing them becomes almost hopeless.

It is the purpose of this book to supply just this sort of information—to present as simply as possible practical information that will enable those concerned with motors to modernize older types of A.C. motors and generators and to replace burned out windings in mdern machines. With some of the old types of machines, the author points out the reduction of losses that can be obtained through the use of a modern winding will pay for the job in less than a year.

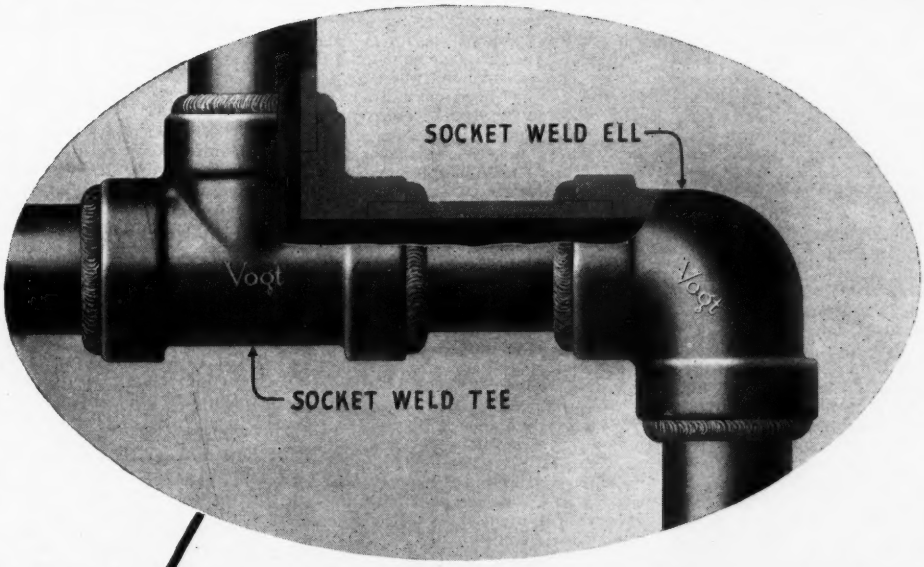
The first part of the book is devoted to the design, construction and insulation of modern type coils for both low and high voltage service. In the later chapters the advantages and limitations of various types of old windings are discussed, with suggestions and examples of the best procedure in replacing them by modern designs.

The last chapter presents the latest information available on the properties of the glass-fabric insulating materials that have recently been developed.

Mr. Van Brunt one of the authors is associate editor of Factory and Maintenance while Mr. Roe is in the transportation Engineering Department of Westinghouse Electric & Mfg. Co.

now!

DROP FORGED STEEL



SOCKET WELD FITTINGS

by Vogt

Easy to weld.. Stronger.. Safer

That same "drop-forge" quality, heretofore obtainable only in Vogt screwed fittings, is now available in Vogt Socket Weld Fittings. The material in these fittings is uniform in structure, fine grained and free from porosity. Because of the similarity of materials in fittings and pipe, it is easy to obtain sound welds.

Vogt Socket Weld Fittings offer these distinctive advantages;

1. Socket for pipe assures positive alignment before and after welding.
2. No weld "icicles" can clog pipe interiors.
3. Bore of fittings matches I. D. of pipe.
4. Extra margin of strength and safety because they are DROP FORGED BY VOGT.

Available from stock in a full range of sizes.

HENRY VOGT MACHINE CO., *Incorporated* LOUISVILLE, KY.

NEW YORK • CHICAGO • CLEVELAND • DALLAS • PHILADELPHIA • KANSAS CITY

Engineering Electronics. By Donald G. Fink. First Edition. 358 pages, 6 by 9, 217 illustrations, cloth. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, 1939. Price $3.50.

In the recent series of articles on Electron Tubes which was published in these pages, it was pointed out that there has been a decided lack of application of electron tubes in the power industry. One of the reasons for this, it was shown, is the lack of electronic knowledge on the part of the engineers who direct developments in the power industry but who nevertheless have a good foundation in electrical engineering. This new book, written by the Managing Editor of Electronics, is designed to meet the needs of just such men. It meets the requirements of the practicing engineer who has a good foundation in electricity but who has no specific training in electronic concepts and methods. The material in the book was originally developed for a lecture course delivered to a group of one hundred men, members of the engineering department of the Westinghouse Lamp Co.

Steering a course between simple descriptions of equipment and elaborate technicalities, the author brings to the reader an adequate introductory working knowledge of electronic conduction, its capabilities and limitations, different types of electron tubes and their special field of use, and circuits in which electron tubes are applied. The practical side of the subject has been developed in a series of typical problems and solutions and by suggestive problems to which commercial answers are given.

Fractional Horsepower Electric Motors. By Cyril G. Veinott. First Edition. 431 pages, illustrated, size 6 by 9. Cloth. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. 1939. Price, $3.50.

This is the best book that has ever come to our attention on the subject of fractional horsepower motors. There may be others as good or better but we have not seen them. A small motor may seem unimportant to engineers who are accustomed to operating machines rated in hundreds and thousands of horsepower but when, as the author points out, it is realized that in the United States alone, the value of fractional horsepower motors sold amounts to around 50 million dollars annually, the importance of a good book on the subject can be appreciated.

The aim of this book is to tell the story of fractional horsepower motors, what types are available, what makes them run, what they will do and how to repair them when necessary. Whether the author has succeeded in realizing this aim will be for the reader to decide, since to a certain extent we believe this will depend upon his background. It has been written so that it may be read or studied constructively from the first to the last page, but as the author indicates it is also written so that any single chapter can be read by itself in order that any reader who may be interested say, only in universal motors may read Chapter XII by itself without studying the eleven chapters preceding it in which he may have little interest.

Technical terms and phrases are defined informally in those places where an explanation appears most appropriate and easily understood. The book is intended for all who have a vital interest in fractional horsepower electric motors, whether it be repair, maintenance, installation, application, inspection, selling, manufacturing or design of such motors. Primarily it was written to serve the needs and interests of practical men engaged in installation, maintenance or repair work.

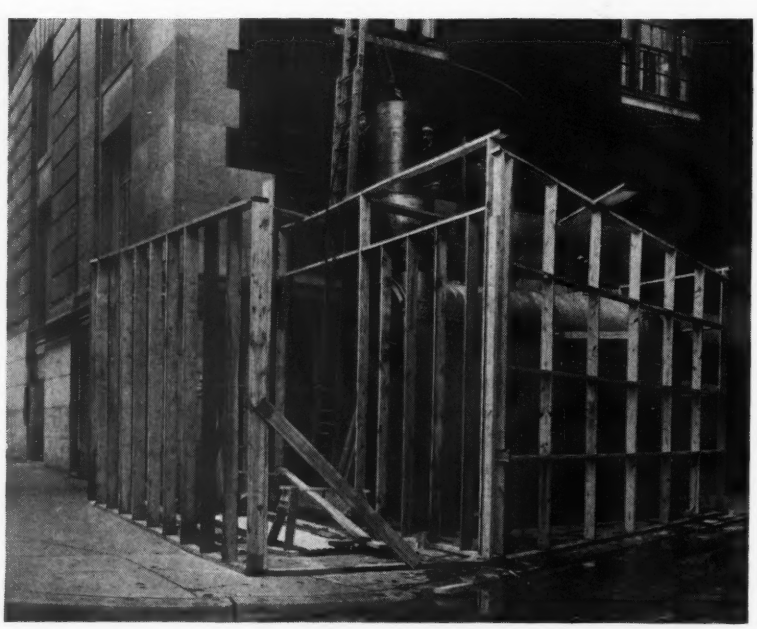
Although the author is design engineer of the Small Motor Engineering Department of the Westinghouse Electric & Mfg. Co., the book deals with all makes and types of small motors. The first chapter, as a matter of fact, is entitled "the story behind the nameplate" and contains a tabulation showing the types and characteristics of motors made by 33 odd manufacturers.

While the chapter on the theory of operation could be more complete, it is still as we said before, far the best book on the subject we have seen. It is exceptionally well illustrated and has a good index.

Tensor Analysis of Networks. By Gabriel Kron. First Edition. 635 pages, 246 illustrations, cloth. 6 by 9 in. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 1939. Price $7.50.

The Application of Tensors to the Analysis of Rotating Electrical Machinery. By Gabriel Kron. First Edition. 200 pages, cloth. 8 by 11 in. General Electric Review, Schenectady, N. Y. 1938. Price $4.50 prepaid.

In reviewing these two books by Gabriel Kron we may as well admit at the beginning that we really know nothing about tensors. True, we have studied these volumes, taken them home, left them on the library table to impress visitors and read them with very learned expressions on the train, but it has not helped us very much. During the past four years we have been intrigued by Mr. Kron's articles on Tensor Analysis in the General Electric Review and we have read other articles which endeavored to explain tensor analysis in simple language but, after all is said and done, most of the pages in Mr. Kron's books still have just about the same significance for us upside down as they have right side up. In all this earnest effort we have become somewhat familiar with the notation used in this branch of mathematics and have acquired a vague if inadequate idea of its purpose; from what little we remembered about determinants we gained an inkling as how the method works but we will not mislead anybody by implying that we know even a little about tensors—we don't.

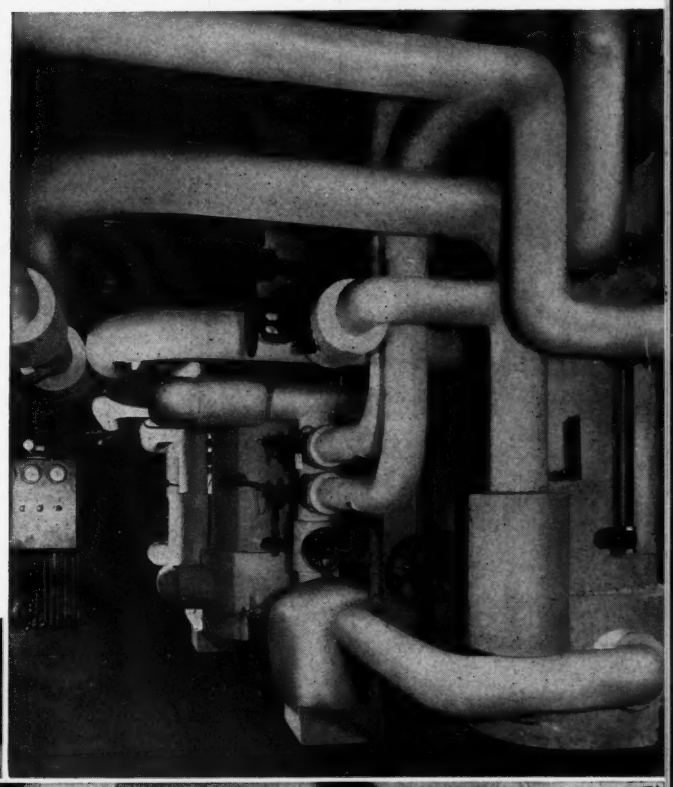


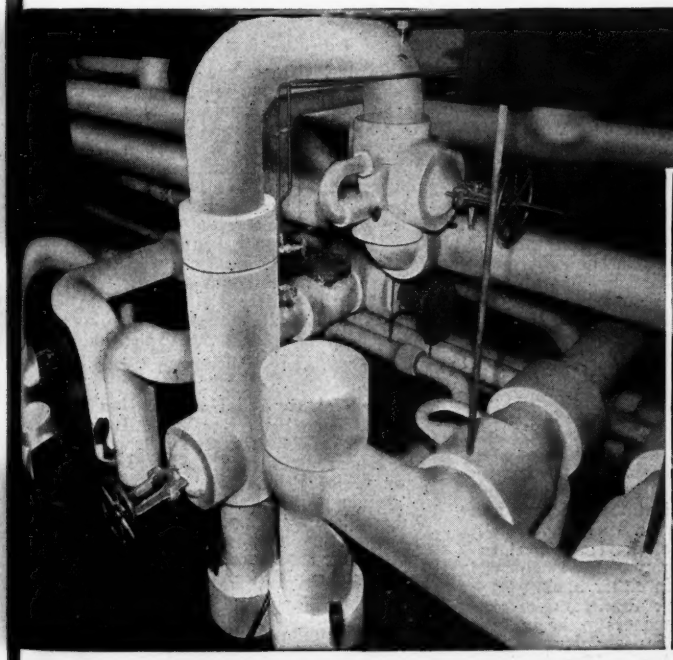
Statler Moves Out

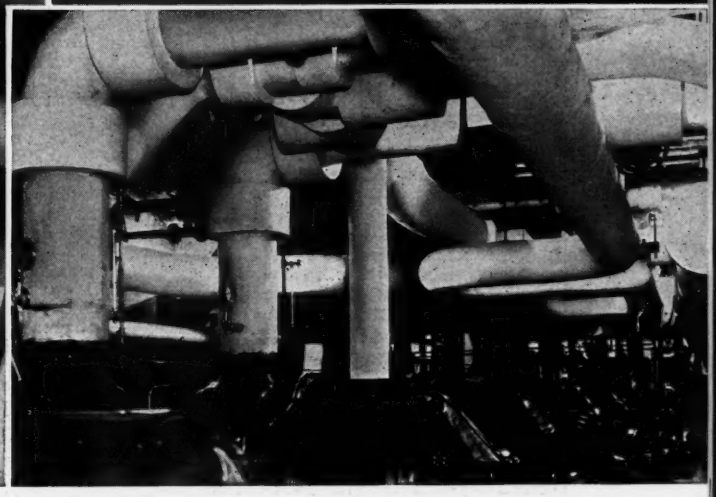
GUY M. NORTON, chief engineer of the Hotel Statler at Cleveland, Ohio, never forgets that the comfort of the guests is the one standard by which Statler service is judged. Therefore, when the boiler room began to show signs of advancing age, he moved right out in the street, and set up an outdoor, sidewalk job with a stripped effect that sets a new style. This boiler will carry the hotel load while the regular boiler room is being modernized and two 107 hp., steel fire tube boilers fired by Iron Fireman Poweram stokers with floating controls are being installed. E. J. Kelly is manager of the Cleveland Statler and Tenney & Ohmes of New York are consulting engineers.

IN HIGH PRESSURE, HIGH TEMPERATURE PIPING

MORE INTRICATE FABRICATING IS ONLY *HALF* THE STORY







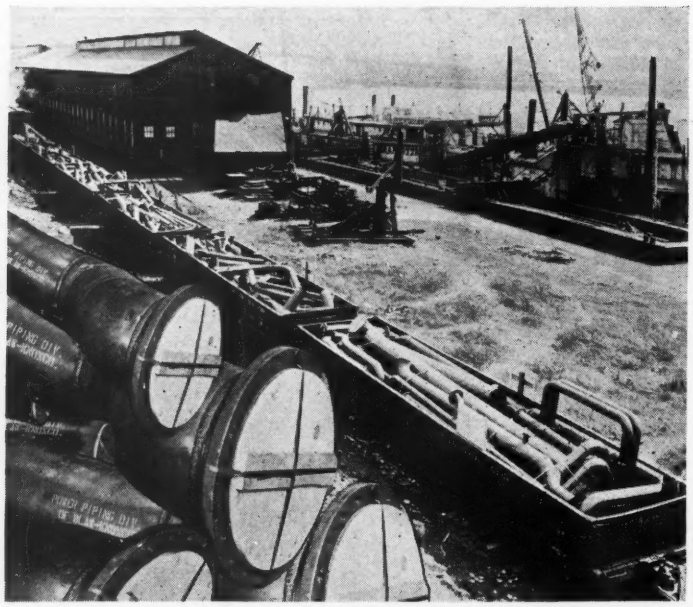
The complexity of modern piping systems is evident in these photographs of high pressure, high temperature systems fabricated and erected by Pittsburgh Piping & Equipment Company. But something these illustrations do not show is the years of experiment and research required to develop correct methods of fabricating this type of work.

The greatly increased wall sections necessitate careful engineering in the layout and detailing of fabricated assemblies. The effect of new metallurgical characteristics on machining, welding and annealing alloy steels calls for the highest degree of skill and most advanced shop technique. For these reasons Pittsburgh Piping has developed new fabricating methods entirely different from those employed in fabricating low pressure piping. Field erection has been perfected to the high degree required by this type of construction.

As working temperatures and pressures increase, Pittsburgh Piping is ready to correctly pre-fabricate and erect complete systems with precision and economy.

PITTSBURGH PIPING & EQUIPMENT CO., 10 FORTY-THIRD ST., PITTSBURGH, PA.

Woolworth Bldg. New York · Occidental Bldg. Indianapolis · Peoples Gas Bldg. Chicago · General Motors Bldg. Detroit · Public Sq. Bldg. Cleveland · 10 High St. Boston · 1st Nat'l. Bank Bldg. Charlotte · 525 Market St. San Francisco



Pipe for Power Plant

NINE carloads of prefabricated pipe will be used in a new power plant of one of the major oil companies. Part of the shipment is pictured here. Power piping division of Blaw-Knox Co. did the fabricating, which featured extensive welding, as will be noted in the close-up at left of photograph. Fittings were kept to a minimum and the bulk of the valves were welded directly into the line. Flanges at flow meters and at connections to equipment are of the Van-Stone type. All welds and bends on the high pressure lines were heat treated and stress relieved in specialized equipment possessed by the fabricator. The high pressure lines will carry steam of 600 lb. pressure at temperatures up to 750 deg. F. Bleeder steam off the turbines, at 150 lb., will be used for the processing equipment; and 15 lb. bleeder steam from the process equipment will be used for the heating system. A total of 365,000 lb. of piping in sizes from 2 to 30 in. is involved.

This constitutes no criticism of Mr. Kron's books nor of tensor analysis, it merely reflects our own mathematical shortcomings. Nor has it lessened our interest in the application of this method of analysis to electrical engineering problems. From the first we have regarded its development with great interest and have enjoyed the discussion and argument which it provoked, particularly Dr. Slepian's fruit salad commentary. Now, with the publication of these new books our interest in the subject is stimulated anew though we feel our mathematical inadequacies more than ever.

Tensor analysis may not be as difficult as it looks—we hope it isn't—and if, as Mr. Kron claims, it has so many advantages, it is worth a great deal of time and study to those who are fitted to use it.

As we understand it tensor analysis is a method for dealing comprehensively and systematically with a multiplicity of variables, an infinite number if necessary. It is the logical sequel to complex number and vector analysis. Whereas complex numbers are limited to the handling of two variables and vector analysis to three variables, tensor analysis has no such limitations.

For many years the types of electromagnetic phenomena encountered in electric circuits and apparatus were relatively simple, but in recent years increasing complexities in operating conditions and the increasing number of variables involved in electric practice created the need for a new mathematical tool which would handle these intricate problems with the same ease that former methods did with simple equations.

Tensor analysis, it seems, is just that tool. For the first time it provides a generalized theory of electrical machinery by which the complete transient and steady state performance of any particular type of machine or group of machines can be derived by substituting the particular brush, collector rings and circuit interconnections in a set of completely general tensor equations. It is a sort of movable, flexible, framework on which to hang all the variables of a particular problem and on which these variables may be carried through a variety of operations without ever considering them individually.

Mr. Kron says that tensor analysis is fundamentally simple and easy to grasp and use when one becomes familiar with its specialized symbolism and algebraic procedure. Its notation he says is so clear, so explicit that the rules of its manipulation are self evident and self checking.

Be that as it may—it is probably true, and we do not for an instant doubt Mr. Kron's sincerity, but do not let us delude you into forming an opinion that either of these volumes makes easy reading. Even those endowed with good mathematical intellects will find considerable application necessary and as pointed out by another reviewer, it will take plenty of good electrical engineers a week or two to absorb even the first chapter in either book.

The first book listed, as its title indicates, applies tensors to the analysis of networks; it is entirely new, the subject matter never having been published before. The second book is a collection of the first 16 parts of the serial published in the General Electric Review from April, 1935, to March, 1938, inclusive. These 16 chapters, however, complete the elementary engineering treatment of the standard types of rotating machinery used in industry.

Welding

Electric Welding. By Morgan H. Potter. Published by American Technical Society, Drexel Ave. at 58th St., Chicago, Ill. Size 5½ by 8 in., 126 pages. Price $1.25.

Covering the fundamental principle of various types of electric arc welding and also including the use of power tube rectifiers, this book is a practical text prepared for the purpose of providing the new or inexperienced welder with the necessary technical and practical information.

The various subjects in this book hav been treated from a practical viewpoint in words and terms common to those who are interested in welding. Although the author has presented a fair sample of welding material, procedure, design and application, he feels that the reader should supplement his study of this text with other reading material on the subject, due to the rapid advancement in this field.

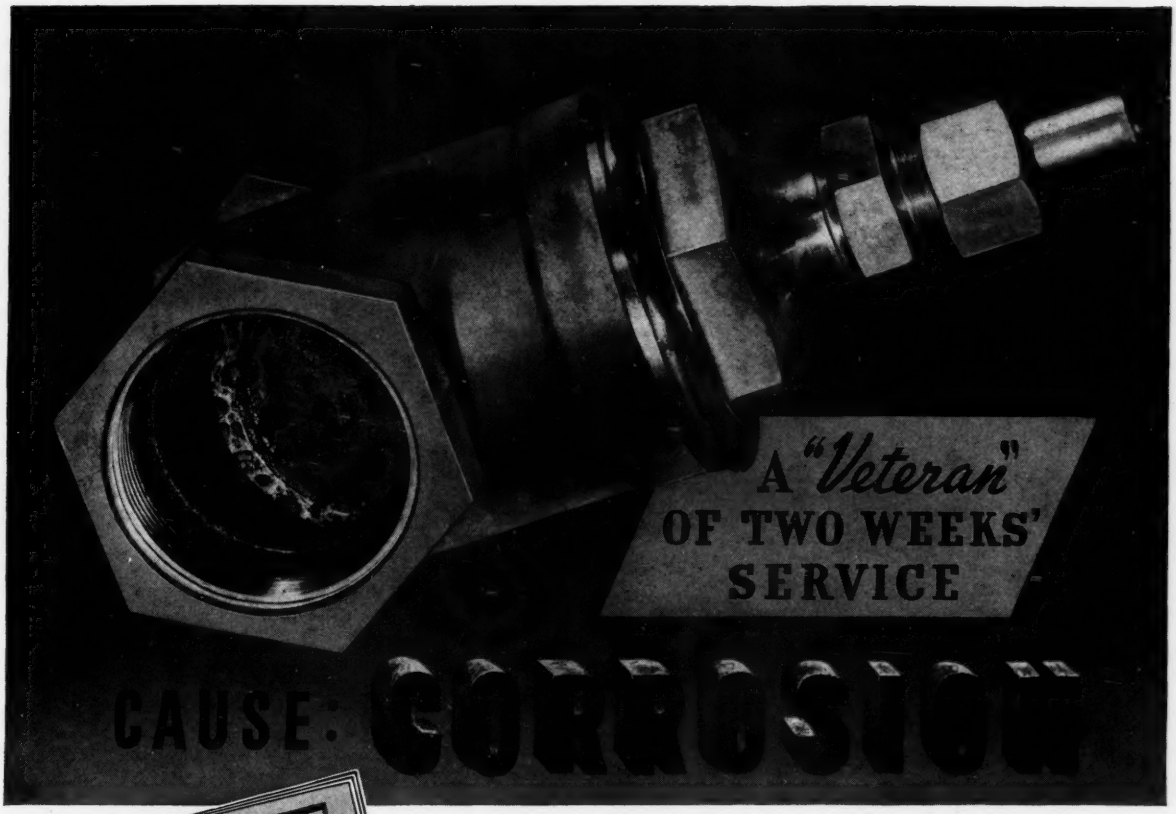
Arc Welding and How To Use It, Third Edition 1938. By W. J. Chaffee. 5½ by 8 in., 340 pages. Published by The Hobart Brothers Co., Box EW 58, Troy, Ohio. Price $1.50.

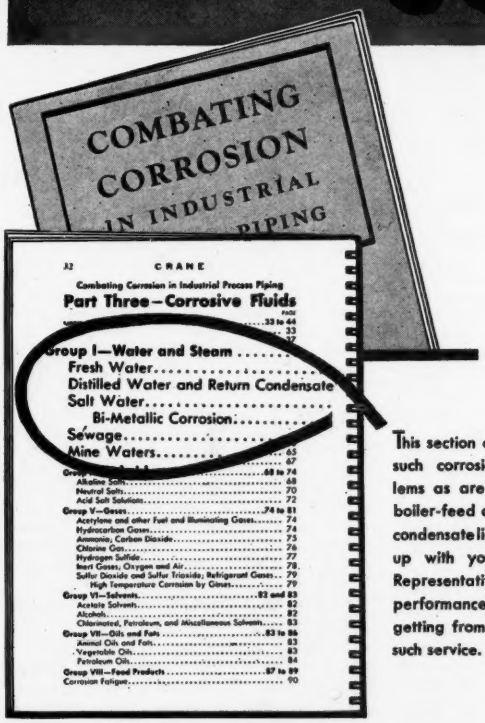
Retaining the simplicity of language and freedom from highly technical discussions, this book gives a complete study of the art of arc welding. It is an enlargement of the Hobart Welding Manual and is as nearly up to date as possible with the continual progress in welding technique and equipment.

Much of the material in this book has previously appeared in other literature published by this company but material that will undoubtedly prove useful has been added, making the book complete with all the material compiled in one volume.

Information on arc welding process and its applications has been greatly amplified in this edition to give the readers a complete and thorough picture of this subject. More detailed instruction exercises, tables and other helpful information are found in the latter part of the book and will be of use to those who are interested in acquiring proficiency in the actual use of the welding art.

This book will be found valuable as a textbook in colleges and universities as well as in trade schools and as a reference book for industrial managers and workers in the field.





This section deals with such corrosion problems as are found in boiler-feed and return condensate lines. Check up with your Crane Representative on the performance you are getting from valves in such service.

Two weeks ago, a new and shining valve. Today, a veteran—still shiny, but unfit for service—crippled by corrosion!

Whether or not corrosion destroys your valves with such rapidity, it is a menace to them nevertheless. Corrosive action is present, to some degree, in practically every industrial fluid processing system. Its toll is told in the piping maintenance budget.

Combating corrosion is not a simple task. The answers to its problems are not found in the back of any book. Yet, if your Crane Representative has shown you a copy of Crane's new book on corrosion in piping, you know that there is available the basic information which leads to control of this destructive force. And you may appreciate the broad experience, the elaborate field and laboratory research upon which the data contained in this treatise is based.

But even more important to the valve user, is that the same thorough knowledge of corrosion reflected in this study, is applied in the making of Crane valves and fittings—that Crane-Quality in piping materials represents the finest developments of alloys for specific service conditions.

Crane promises no panacea for corrosion—there is no such thing. But with the engineering knowledge and experience that back the facts in "Combating Corrosion In Industrial Process Piping," with unmatched research and plant facilities, Crane assures you of dependable flow control at minimum cost. Consult your Crane Representative.

CRANE

CRANE CO. GENERAL OFFICES
836 S. MICHIGAN AVE., CHICAGO
VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL MARKETS

Power Plant Construction News

Ala., Gadsden—Goodyear Tire & Rubber Co., Akron, Ohio, plans installation of electric power equipment in four-story addition to branch automobile tire and tube mill at Gadsden, 100x100 ft. Work will begin soon. Entire project is reported to cost over $150,000.

Calif., Cupertino—Permanente Corporation, recently organized interest of Henry J. Kaiser Co., Latham Square Building, Oakland, Calif., engineering contractor, plans installation of electric power equipment in new cement mill in Permanente Canyon district, near Cupertino, to furnish cement for Federal projects in California, including Shasta dam, for which company has secured award totalling $11,025,892. New mill will consist of several units, including power plant, and is estimated to cost close to $4,000,000. Work is scheduled to begin at early date, with completion early in 1940.

Conn., New Britain—City Council is considering preliminary plans for new municipal electric power plant. Surveys and estimates of cost are in progress. Louis T. Klauder, Lincoln-Liberty Building, Philadelphia, Pa., is consulting engineer.

Ga., Atlanta—Chevrolet Motor Division, General Motors Corporation, 3044 West Grand Boulevard, Detroit, Mich., plans installation of electric power equipment in new one-story branch assembling works, 120x720 ft., at Atlanta, where site has been acquired. Work will be placed under way soon. Entire project is reported to cost over $400,000.

Ga., Atlanta—National Biscuit Co., 449 West Fourteenth Street, New York, N. Y., plans installation of power equipment in new branch plant on Murphy Avenue, S.W., Atlanta, with baking division to include traveling ovens, conveyors and other mechanical-handling equipment. Work is scheduled to begin in the fall. Cost reported about $1,000,000. Louis Wirsching, address noted, is company architect.

Ill., Chicago—Rival Packing Co., 371 South Halsted Street, meat packer, plans installation of power equipment in new three-story and basement plant, 118x175 ft., at Forty-fifth Street and Tripp Avenue. Also will install a refrigerating plant and system, and air-conditioning system. Entire project will cost about $350,000. A Epstein, 2001 West Pershing Road, is engineer. E. T. Keller is secretary.

Ill., Springfield — Department of Water, Light and Power, S. J. Sibley, superintendent, is considering preliminary plans for new municipal electric light and power plant at Lake Springfield, supplementing present station. Cost reported close to $500,000. Proposed to arrange financing in near future.

Ill., Woodstock—Alemite Die-Casting & Mfg. Co., Thomas Street, plans installation of electric power equipment in new one-story addition to plant, 270x470 ft. Entire project is estimated to cost about $175,000. Company is a subsidiary of the Electric Auto-Lite Co., Champlain and Mulberry Streets, Toledo, Ohio.

Ind., Logansport — City Council plans extensions and improvements in municipal electric light and power plant, including installation of additional equipment. Estimates of cost are being made. Charles Ammerman, Century Building, Indianapolis, Ind., is consulting engineer.

Iowa, Jefferson — City Council will make surveys and estimates of cost at once for proposed municipal electric light and power plant. Diesel engine-generator units are being considered. K. R. Brown, Valley Bank Building, Des Moines, Iowa, is consulting engineer.

Iowa, New London—Town Council has plans under way for new municipal electric power plant, using Diesel engine generator units and accessory equipment. Estimates of cost are being made. Young & Stanley, Inc., Muscatine, Iowa, is consulting engineer.

Iowa, Preston — Common Council will have plans prepared soon for new municipal electric power plant. Proposed to use diesel engine-generator unit and accessory equipment. Bond issue of $45,000 has been authorized.

Kan., Salina—City Council is planning installation of new water-softening plant for municipal water system, with capacity of about 10,000,000 gal. Estimates of cost will be made soon. Paulette & Wilson, Farmers' Union Building, Salina, are consulting engineers.

Ky., Louisville—P. Lorillard Co., Michigan and Thirty-first Avenues, has approved plans for addition to boiler house at local tobacco factory, including improvements in present plant. Additional equipment will be installed. No estimate of cost announced. A. M. Kinney, Inc., Carew Tower Building, Cincinnati, Ohio, is consulting engineer.

Mich., Detroit—Solvay Process Co., West Jefferson and Solvay Streets, plans new boiler house at local plant. Cost estimated about $35,000, with equipment.

Mich., Kalamazoo — American Cyanamid & Chemical Corporation, 30 Rockefeller Plaza, New York, N. Y., plans installation of electric power equipment in new branch plant at Kalamazoo, comprising several one-story units. Entire project will cost close to $300,000. Erection will begin soon. Company is a subsidiary of the American Cyanamid Co., first noted address.

Mich., Trenton—Monsanto Chemical Co., 1700 South Second Street, St. Louis, Mo., plans installation of electric power equipment in proposed new branch plant at Trenton, where options have been secured on tract of about 160 acres of land. It will comprise several large production units. A power house will be built. Entire project is reported to cost over $2,000,000.

Neb., Hastings—Nebraska Refining Co., Hastings, M. H. Robineau, manager, plans power house at proposed local oil refining plant. Also will build a pumping station and other mechanical departments. Entire project is estimated to cost close to $400,000. Planned to begin work soon.

Ohio, Dayton—Dayton Power & Light Co., plans expansion and improvements in steam-electric generating station, including installation of new 40,000-hp. turbine-generator unit and accessories, high-pressure boilers and auxiliary equipment. Work will be carried out during next 12 to 18 months and is reported to cost in excess of $1,000,000.

Ohio, Dayton—Univis Lens Co., 46 Cannon Street, plans installation of electric power equipment in new four-story and basement addition, 46x100 ft., to optical lense-manufacturing plant. Cost estimated over $75,000. Geyer & Neuffer, Ludlow Arcade Building, Dayton, are architects.

Ohio, New London—Rotary Printing Co., Norwalk, Ohio, plans installation of power equipment in connection with rebuilding of branch plant at New London, operated in name of B. F. Harrison Printing Co., recently destroyed by fire. Loss estimated at $175,000, with machinery.

S. C., Union — Lyles Ford Tri-County Power Authority, Union, has preliminary plans under way for three hydroelectric power plants on Broad, Tiger and Encoree Rivers, respectively, with total capacity of 72,000-hp. Project will include about 250 miles of transmission and distribution lines, and is reported to cost over $2,000,000. Application has been made for Federal permission.

Tenn., Chattanooga—Gulf Refining Co., Gulf Building, Pittsburgh, Pa., plans new bulk oil terminal on tract of about 25 acres of land on Manufacturers Road, Chattanooga, with frontage on Tennessee River, recently acquired to include pumping station, steel tank storage and distributing units and other operating structures. Cost reported over $85,000.

Wash., Okanogan — Okanogan Growers' Union plans rebuilding of cold storage and refrigerating plant, recently destroyed by fire in conjunction with main packing house. Entire loss estimated at close to $130,000, including equipment.

W. Va., Charleston — Carbide & Carbon Chemicals Corporation, 30 East Forty-second Street, New York, N. Y., plans installation of electric power equipment in new addition to branch plant at South Charleston, comprising several new units for large increased production. Proposed to begin work soon. Entire project is estimated to cost over $1,000,000. Company is a subsidiary of Union Carbide & Carbon Corporation, first noted address.

Wis., Eau Claire—Board of Eau Claire County Commissioners has plans under way for steam power house for heating service for county buildings. Cost estimated about $35,000. Howard M. Nelson, 204 East Grand Avenue, Eau Claire, is architect.

Wis., Kaukauna — Department of Municipal Utilities plans new municipal hydroelectric power plant, to supplement present city-owned power station. Cost estimated over $450,000. Mead, Ward & Hunt, State Journal Building, Madison, Wis., are consulting engineers.